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THE ORGANIZATION OF KNOWLEDGE AND THE SYSTEM OF THE SCIENCES

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THE ORGANIZATION OF KNOWLEDGE
AND
THE SYSTEM OF THE SCIENCES

BY

HENRY EVELYN BLISS

ASSOCIATE LIBRARIAN
THE COLLEGE OF THE CITY OF NEW YORK

WITH AN INTRODUCTION

BY

JOHN DEWEY

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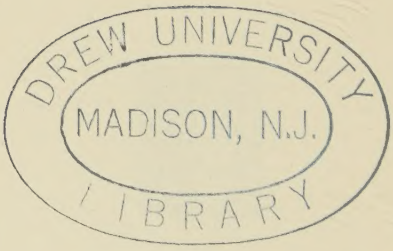

BROTHERS COLLEGE

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To the
Scientist who is an organizer,
to the
Organizer who is a scientist,
and to the
Educator, who is both organizer and scientist,
and especially to the
Librarian,
who is educator, organizer, and scientist,
this work is earnestly dedicated.

BROTHERS COLLEGE

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. . . . the crowning race

Of those that, eye to eye, shall look
  On knowledge; under whose command
  Is Earth and Earth's, and in their hand
Is Nature like an open book; . . . .

Tennyson, *In Memoriam.*

The pragmatic value of organization is so conspicuously enforced in contemporary life that it hardly seems necessary to dwell upon the instrumental significance of classification and systematization.

John Dewey, *Reconstruction in Philosophy.*

INTRODUCTION

Most of us, even those who use libraries constantly, think of them, I imagine, mainly in reference to our own personal needs. We take them for granted, and judge them by their practical efficiency in supplying us with what we want when we want it. Mr. Bliss's monumental work comes as a shock to this narrow personal attitude. That the problem of the organization of libraries connects on the one side with the scientific and educational organization of knowledge and on the other side with the promotion of social organization this book makes impressively clear. It includes, moreover, the questions of psychology concerned with effective, growing assimilation of knowledge and the logical and philosophical questions involved in the problem of the unity, interrelations, and classifications of science.

On the other side, the social side, it also makes clear that our practical activities are more and more dependent upon scientific discoveries, intellectual progress and the diffusion of genuine knowledge. Social organization depends increasingly on ability to utilize organized knowledge competently, and decreasingly on tradition and mere custom.

Underlying the treatment is a sound philosophy of the relations of the special and particular to the comprehensive and general, of theory to practice, of organization and standardization to freedom and to the needs imposed by constant growth and change. The range of solid scholarship which has been drawn upon will be obvious even to the casual reader. But the learning and the philosophy are handled as effectively as the style and treatment are clear and direct.

The modern library stands at the cross-roads where meet together the two great currents of intellectual integration and practical application in the interests of a more unified social life. This work of Mr. Bliss is a well-documented and thoroughly scholarly demonstration of this fact. He has lifted the whole question of organization of libraries up to a plane where it is evident that under modern conditions of life libraries occupy a central and strategic position.

The reader learns to understand, as he follows the thought of Mr. Bliss, that a library is not a mere depository of books, and that a merely arbitrary classification does not satisfy even the practical needs. A classification of books to be effective on the practical side must correspond to the relationships of subject-matters, and this correspondence can be secured only as the intellectual, or conceptual, organization is based upon the order inherent in the fields of knowledge, which in turn mirrors the order of nature. The library serves a practical end, but it serves it best when practical tools and instrumentalities agree with the intrinsic logic of subjects, which corresponds to natural realities. The right organization of knowledge in libraries embodies, moreover, a record of attained unification of knowledge and experience, while it also provides an indispensable means to the development of further knowledge.

Knowledge grows by specialized piece-meal increments; but unless the special worker is to become unaware of the relations and the meaning of what he is doing — unless in the end chaos is to result, there must be a central order based on comprehensive and unifying principles. Yet the order must be sufficiently flexible to adapt itself to new and unforseen growths.

In consequence of this broad and liberal spirit Mr. Bliss's book, in addition to its special value to those directly concerned with the services of books, is of importance also to all those who are interested in the bearing of the organization, and the interrelations, of knowledge upon the transition from

anarchy and chaos to order and unity in life. Intellectual coöperation and collective attack on complex problems, drawing upon materials of diverse kinds, are marked movements of present life.

Of the many special points of interest which are included in the comprehensive plan of Mr. Bliss's work, there is one which I should like to single out for special attention. In the broadest sense of education, the dominant concern of this work is educational: the problem of the ideal of library organization is the educational service it should render both to the general public and to the workers in special fields. But it is also closely connected with education in its narrower sense of what goes on in schools. There is no educational question more pressing than that of the right relation of special and departmentalized instruction to the all-round, balanced development of students and teachers. Because of this need, our colleges are introducing "orientation" and "survey" courses. There is hardly an institution that is not experimenting to produce a better correlation of studies. Specialization has been carried so far that the great need now is that of integration.

Apart from its permanent contributions to the solution of the general problem of the organization of knowledge, this work of Mr. Bliss is, in its general scope and in its details, an important and much-needed contribution to the accomplishment of this special educational task, which at the present time has become urgent and dominant.

JOHN DEWEY

Yet the fact that improvement in organization yields practical results in the various special sciences justifies our faith that a still wider improvement of organization which aims to bring all the facts and principles of all sciences into a coherent system will work an influence on practical life commensurate with its comprehensive character. . . . Improvement in the organization of facts and principles means that they are more closely related to one another; that, instead of being 'massed', they are shot through with a multitude of connections; and that in virtue of these connections, they may be recalled most readily and applied most effectively. . . .

The fact that the organization of experience in coherent systems is a fundamental factor in promoting the application of experience to the practical improvement of adjustment is profoundly significant to the process of education.

WILLIAM CHANDLER BAGLEY, *The Educative Process.*

PREFACE

This book should be of interest, we think, to educators and philosophical readers who recognize the intellectual and the social values of what is termed the organization of knowledge, to scientists who realize the methodic and economic advantages resulting from the systemization of scientific knowledge and research, and finally to librarians who, maintaining that books in libraries should be well classified, acknowledge the importance of making the classification consistent with the organization of knowledge as conceived and systemized by scientists and educators. These several classes of readers are in their different ways interested in the organization of knowledge.

What is meant by the *organization of knowledge?* Those who desire our immediate answer may turn to Chapter IV, which is addressed mainly to that question. But the special uses of the phrase, whether by educators, scientists, or philosophers, have become so current — if not quite definite — that such anticipation of our definition seems unnecessary here. We shall merely indicate that in the broader sense, in which the term applies to the subject of this volume, the organization of knowledge comprehends not only the *mental* processes, the development of concepts and the conceptual synthesis of knowledge, but also the *intellectual* correlation and systemization of valid knowledge, from the simpler social synthesis of common experience and elementary education to the more complex conceptual systems of science and philosophy.

In all these processes and methods there inhere classifications of some kind and form. Classification is fundamental to the organization of knowledge. The study of the principles, methods, and forms of classification should therefore be of interest.

But there are minds that disapprove, and some that just *detest* organizations and classifications, which they regard as the colt his chafing harness or the bird his imprisoning cage. The writer sympathizes, on one side of his nature and experience, with their emotional dissent. To individualists and liberalists who may be averse to such organizations of knowledge and purpose as might fortify the developing forces of social organization, which they may regard as already too oppressive, we would indicate the second section of the first chapter as intended to meet some of their objections, as well as to reassure them of our own liberal views.

The intellectual and economic needs of humanity are not fulfilled by mere coöperative accumulation and arbitrary classification of the data of knowledge and the materials of utility. In the earlier stages of organization indeed all hands and minds may be wholly occupied with the preliminary work of collecting, naming, marking, and indexing. The workers may for the time regard such methods and results as satisfactory. This state of mind the writer has termed "the subject-index illusion", with special reference to a certain famous subject-index to the contents of public libraries.

In subsequent stages tentative classifications, conceptual or practical, may be adopted; and, tho crude and arbitrary, they are likely to become established in a conservative historical and economic situation. All classifications are in truth relative to views or conceptions, interests or purposes, and are therefore in some respects arbitrary and conceptual. But with growing experience, knowledge, and education the relevant classifications become progressively rational and systematic. This developing organization of knowledge is not, however, rigidly structural and static, but functional and plastic, and it should be liberally adaptive to new interests and changing communal conceptions.

In view of the relativity of classifications it is often argued that systems are impermanent and that there is no established consensus. Yet impermanent systems may be *relatively*

permanent, and a consensus may prevail for at least a generation, and for a class of minds. In fundamentals, in general ideas and relations, the system of knowledge, the systems of classification, and the consensus in which they are established, are no less durable than other systems of nature and of human society, and in their details they are hardly more changeable. In brief, *general* ideas, general classes, and general relations are relatively *permanent*. The more consistent the general plan is with the established systems of science, the more efficient and the more permanent the system of classification will prove to be, even for special and various purposes.

The most adequate classifications are, generally speaking, those that are most consistent with the organizations of knowledge relevant to the interests in view. Their truth and efficiency depend upon two fundamental principles: (1) *subordination* of the more specific to the more generic relevant terms, or subjects; (2) *collocation* of closely related subjects for convenience in reference or use, for *maximal efficiency*.

That this is the first undertaking to treat this subject comprehensively and with an approach to thoroness is a claim that the writer thinks he may make with truth. A second claim that he feels entitled to put forth is that he has stated and adduced certain principles that heretofore have been but vaguely conceived or have been secluded in treatises on logic. Thirdly he submits that the system of knowledge he has outlined in tabular form schematizes a more coherent system than any of those he has criticised in the historical chapters (Part IV). In this it may succeed chiefly because, without differing too radically from the truth of historic systems, it avoids their most patent errors.

The historical part is justified in that it treats the historical material in a broader topical and comparative way than does Flint's scholarly and authoritative volume; and there is no other adequate historical account.

If a reader finds that parts are irrelevant to his interests, he may turn to other parts that more especially concern him. The relation of the parts to the whole may be gathered from the epitomes that precede the sections of the chapters so as to assist readers to select or to omit. Paragraphs of very special interest are moreover subordinated in smaller type thruout the work.

We have tried to treat a very comprehensive subject broadly and without prejudice. Our personal attitudes in certain questions may, however, be expressed with a measure of vivifying emphasis. Tho the readers of the several classes we are addressing together may concur in fundamentals, they will of course differ in views and interests, and they must sometimes be taken apart.

Scientists, tho interested in the synthetic aspects, may be inclined to disregard a work that is so largely intended for educators and librarians. The obvious remark is that they may read only those chapters that most interest them. On the whole, however, it might behoove scientific readers of broad interests to know more about what educators and librarians are undertaking in their interests in a structural and functional organization of knowledge.

Some librarians may object that certain chapters are beyond their ken. But those we chiefly address have college education for all this, and more. Librarianship — as Dr. Williamson's report for The Carnegie Corporation on *Training for Library Service* affirmed some years ago — is in especial need of such comprehensive books for professional study.

But the three-fold interest and purpose inhere in the very nature of the subject. Classification for libraries can be adequate and efficient only if grounded on the fundamental principles of the organization and classification of knowledge, and this outstanding problem should not be disposed of without due regard to the educational aspects and interests involved. That the study of classification extends into logic and psychology should not deter the educated librarian, if

those matters are treated clearly and not too profoundly. That the subject is shown in its broader social relations should enhance the value of this presentation to the librarian as well as to the educator.

The problem of classification for libraries has become more difficult on the one hand from the increased momentum of certain going concerns and on the other hand from the rapidly accelerated progress of organization in science, technology, industry, and social amelioration. With this a more positive need for organized knowledge has become manifest, and a more positive demand for better classification for libraries. The time has come when this important problem should be given purposeful consideration in the interests both of library service and the functional organization of knowledge.

Scientists and philosophers may find some of these chapters superficial in places, but not, it is hoped, erroneous; for to guard against errors and vagaries the writer has submitted the several chapters to the scrutiny of colleagues well qualified in the respective subjects. Their assistance is gratefully acknowledged in naming them here; but they are of course absolved from responsibility for statements that originally and finally are the writer's, not theirs. To Professor Harry Allen Overstreet, head of the Department of Philosophy, to Professor Paul Saurel, of the Department of Mathematics, to Professor Alexander Marcus, of the Department of Physics, to Professor Reston Stevenson, of the Department of Chemistry, to Professor Bertram T. Butler, of the Department of Geology, to Professors George G. Scott and Abraham Goldfarb, of the Department of Biology, to Professor J. Salwyn Schapiro, of the Department of History, to Professor Bird Stair, of the Department of English, and to Professor Homer Curtis Newton, of the Department of History, and Librarian of the College, — to these severally I render thanks for advice, criticism, comment, and approval, regarding their special fields of interest.

The work has been rendered possible by the liberality of the executive heads of The College of the City of New York, who have permitted the writer to apply to this purpose a large part of his time during the past six years. But for twenty years or more his interest in the subject has been a dominant one.

For advice, criticism, and appreciation I am especially grateful to Dr. Harry Lyman Koopman, Librarian of Brown University, to Dr. Ernest Cushing Richardson, Consultant in Bibliography in the Library of Congress, to Mr. Charles Martel, Chief of the Catalogue Division of the Library of Congress, to Miss Grace Osgood Kelley, Supervising Cataloguer and Classifier of the John Crerar Library, to Miss Josephine Adams Rathbone, Vice-Director of the Pratt Institute School of Library Science, to Professor Andrew Keogh, Librarian of Yale University, to Mr. George Burwell Utley, Librarian of the Newberry Library, to Mr. Harrison W. Craver, Director of the Engineering Societies' Library. Professor Burton E. Livingston, Permanent Secretary of the American Association for the Advancement of Science, and Mr. Joseph Ratner, a lecturer in Philosophy in Columbia University, have read parts of the book and have given me valuable advice and criticism. To Professor Stephen Pierce Duggan, Director of the Institute of International Education, and Mr. Sidney W. Noyes, Vice-President of the New York Trust Company, I owe especial thanks for assistance and appreciation.

The books that have influenced one can never be named all together; but those that have best informed and sustained one's thought and purpose may sometimes be severally mentioned with justice as well as with gratitude. In the Bibliographic Notes that appear at the end of the volume several debts of this kind are acknowledged. Other or lesser debts are mentioned or implied in footnotes thruout the chapters.

HENRY E. BLISS.

The College of The City of New York,
MARCH, 1929.

CONTENTS

PAGE

INTRODUCTION vii
PREFACE xi

PART I. THE ORGANIZATION OF KNOWLEDGE

CHAPTER

I. KNOWLEDGE IN RELATION TO SOCIAL ORGANIZATION.

1. The Need for Organized Knowledge 3
2. Individualism, Freedom, and Progress 8
3. Functional Organization and Purpose 15
4. Great Failures and Great Hopes 21

II. PROGRESS TOWARD COMPLETER ORGANIZATION.

1. Social, Political, and Economic Organizations 27
2. Economic Simplification and Standardization 37
3. Ameliorative, Ethical, Religious, and Patriotic Organizations 43
4. Intellectual Coöperation and Educational Organizations . . 46
5. Functional Organizations Depend on Structural Organizations of Knowledge 56

III. THE ORGANIZATION OF SCIENCE.

1. National and International Organization 61
2. Functional and Coöperative Organization 66
3. Synthesis and the System of the Sciences 70

IV. WHAT IS MEANT BY ORGANIZATION.

1. Some Relevant Definitions 74
2. Biological and Psychological Implications 76
3. Kinds, or Stages, of Organization of Knowledge . . . 78
4. The Organization of Knowledge in Education 81
5. Organization of Knowledge in Museums and Exhibits . . 89

V. BOOKS AND LIBRARIES.

1. Knowledge Organized in Books and in Libraries . . . 93
2. Organizing Knowledge in the Publishing of Books and Journals . 95
3. Functional Organization of Knowledge in Libraries . . . 101
4. Conservatism in Classification for Libraries 103
5. Better Classification Desired by Scientists and by Librarians . 108
6. Practical, Scientific, and Educational Values Merge . . . 113

PART II. CLASSIFICATION, SYNTHESIS, AND THE ORDER OF NATURE

CHAPTER PAGE

VI. Classes and Concepts.

1. What a Class Is 118
2. Are Classes Real or Conceptual? 125
3. A Scientific and Critical Realism Stated 127
4. Groups 131
5. The Definition of the term *Class* 132

VII. Definition, Names, and Logical Division.

1. Definition in relation to Classing 134
2. Names and Terminology 138
3. Logical Division 139

VIII. Classification.

1. Some Relevant Distinctions 142
2. Classifying as a Method of Mind 144
3. The Limitations and the Relativity of Classification . . 147
4. The Kinds of Classification and their Terminology . . . 149
5. The Forms of Classification: Dichotomy and Series, Subordination and Coördination 151
6. The Principles of Classification Summarized 156

IX. Relations, Synthesis, and System.

1. Relations 158
2. The Relativity of Knowledge 161
3. Mental Synthesis 163
4. The Unity of Reality and the Unification of Science . . 165
5. System and the Universe 168

X. The Order of Nature.

1. Scientific Realism and the Monistic Universe 170
2. What we Mean by Nature 173
3. The Constituent Realities of this Order 176
4. Development and Evolution 179
5. The Order of Nature Defined 183

PART III. THE SYSTEM OF THE SCIENCES

CHAPTER PAGE

XI. Science and the Sciences.

1. The Definition and the Scope of Science 189
2. Special Sciences 198
3. Branches and Sub-sciences 200
4. Composite Sciences and Complexities of Science . . . 202
5. New Sciences and the Permanence of Sciences . . . 205
6. Applied Sciences 211

XII. Gradation by Speciality and the Correlative Orders.

1. Generalization, Specialization, Gradation, and Dependence . 214
2. The Natural Order of the Sciences 219
3. The Developmental Order in relation to the Logical Order . 222
4. The Pedagogic Order 226
5. Five Tables Synoptic of the Correlative Orders . . . 229

XIII. Preliminary to the Classification of the Sciences.

1. The Purpose and the Problem 236
2. The Point of View 239
3. The Tree and its Branches 245
4. Some Terminological Preliminaries 249

XIV. The Main Divisions and the Fundamental Sciences.

1. General Philosophy and General Science 253
2. Abstract Sciences and General Methods of Science . . 258
3. The Natural Sciences 260
4. The Physical Sciences 263
5. The Biological Sciences 269

XV. The Studies of Human Nature, Life, and Art.

1. The Anthropological and the Psychological Sciences . . 278
2. The Social Sciences 281
3. Religion, Ethics, and Theology 287
4. Political Science, Jurisprudence, and Economics . . . 292
5. Industries, Technologies, and Arts 295
6. Recapitulation and Table 299

PART IV. A HISTORICAL SURVEY OF SYSTEMS OF KNOWLEDGE

CHAPTER

XVI. From Plato and Aristotle to Bacon and Hobbes.

PAGE

1. The Greek Triad 308
2. *Trivium et Quadrivium* 311
3. Precursors of Science 314

XVII. From Leibniz and Kant to Arnott and Ampère.

1. Where Great Philosophers Misconceived and Failed . . 323
2. The Arts and the Sciences 328
3. The Historic Encyclopedias and Dictionaries . . . 331
4. Conceptual Systems of Science 335

XVIII. Comte's Graded Series and Spencer's Abstract-concrete Division.

1. Comte's "Hierarchy" 341
2. Spencer's Untenable Divisions 345
3. The Abstract-concrete Blunder Persistent. 350

XIX. Modern Cross-classifications and Conceptual Systems.

1. Cross-classification Professed 358
2. Conceptual, Psychological, and Subjective Systems . . 367
3. The Congress of Arts and Science 375

XX. The Most Valid and Adequate Modern Systems.

1. Wundt's Great Failure 381
2. Three Lesser Failures 386
3. Some "Almosters." 388
4. Is the Problem Still Persistent? 398

XXI. Summary and Conclusion.

1. Survey of the Problem and the Principles Involved . . 405
2. The Order of Nature and the System of the Sciences . . 408
3. The Dominant Library Classifications are Disqualified as Organizations of Knowledge 411
4. Educational and Intellectual Values Should Avail . . 413

Bibliographical Notes 415
Index 421

PART I

THE ORGANIZATION OF KNOWLEDGE

Knowledge, activity with a purpose, life developed in society, these are the specially human characteristics; and social progress, as we can trace it in history, is the expansion of these qualities. And the evolution is then most clearly toward a better state, when the three factors draw together, as knowledge inspires the purposeful activity, and as the purposeful activity arises from the whole society and is aimed at the development of the life of all.

F. S. Marvin, in *Science and Civilization*.

The teachings of biology and of human history indicate that further social progress must lie in the direction of the rational coöperation of all mankind.

Edwin Grant Conklin, *The Direction of Human Evolution*.

CHAPTER I

KNOWLEDGE IN RELATION TO SOCIAL ORGANIZATION.

1. THE NEED FOR ORGANIZED KNOWLEDGE.

The welfare, the economy, and the very sustenance of human life depend on the social application of more adequately organized knowledge. This implies paramount need for social coöperation. Education should inculcate these ideas and duties.

Tho the increasing knowledge of nature and of human nature has been the best attainment of the modern era, and tho this marvelous development of man's mind has in a sense been "organized", it has in nearly every domain lacked mental and social organization for clearer and completer comprehension and for more effectual coöperative application to the outstanding problems of human life. Great tho the gain has been, much more remains to be accomplished. More facts even, more contributions, but more judicious coöperative selection of the fit and relevant; more pertinent correlations, more valid inferences, clearer insights, and more rational verities, but, above all, more coherent synthesis and more comprehensive organization are requisite to the desiderated "advancement" and the logical clarification of our intellectual and educational systems. More adequate and liberal education to inform, to socialize, and to spiritualize the still half ignorant and half barbarous peoples; more competent and considerate regulation of social relations and institutions, more concerted and effective application of knowledge to the needs and economies of modern life, — these are necessary, hardly less than food and shelter and tools, to the continued

sustenance, the desired welfare, and the developing civilization of humanity.

The progress of knowledge seems in many views discouragingly slow and uncertain, and its application to social amelioration clogged with difficulties. Hopeful gains have too often been countervailed by disorganizing evils engendered in the past and persistent in present conditions. Coöperation, whether in scientific, in social, or in economic interests, has again and again proved ineffectual from lack of organized knowledge and purpose. Accepted theories and provisional solutions are shaken, or shattered, by destructive criticism. Some are displaced by even less tenable novelties — attractive but transitory. Metaphysical contraptions or anti-intellectual reflections sometimes supervene. By flat contradictions scientific authority is discredited; by sophistries rational thought is subverted; and by a babel of tongues liberal education is confused.

The astute politician, the smug capitalist, the frenzied financier, the gesticulating socialist, the urban manufacturer, the rural housewife, the medical practitioner, the scientific specialist, the dreaming artist, and the beaming philanthropist have all in their several ways lacked knowledge even of their own special fields; and beyond their limited and hazy horizons they have lacked understanding of essential and effectual relations to the more comprehensive systems of knowledge and thought.

Natural resources are being rapidly depleted. At the present accelerating rate of consumption, the available stores of oil, timber, and other necessities will probably, according to judicious estimates, be almost wholly exhausted in the next generation. They should be more systematically conserved and economized. We are consuming the forests, said Dr. Charles D. Walcott, in his address as retiring President of the American Association for the Advancement of Science in 1924, four times as fast as they are growing, and at this reckless rate they will last only about thirty years. The

Federal Oil Conservation Board's Report in 1927 stated that the reserves of oil in the lands of the United States were about four and a half billion barrels. But three billion barrels were taken out in the preceding five years. If this be anywhere near the truth, the certain supply would last only a few years. Other resources must be found, if this consumption is to continue. The World Power Conference on Fuel, held at London in 1928, urged economy thru coöperation in applying recent knowledge. Opinions and estimates differ,[1] but the need for conservation is generally recognized.

Scientists are expected to discover where other resources are accessible, what may be mined, what may be raised from the soil, what may be transmuted from the elements; how the production and the consumption of essential commodities may be economized in present uses, and how their conservation may be effectuated for the future wants of our progeny. "But," Lord Moulton said a few years ago to the British scientists, "we can no longer wait for the slow results of casual discovery." For these great purposes science and technology stand in acknowledged need of more systematic organization and more efficient coöperation.

These needs and interests the men and women who know and teach must show to the men and women who work and rear, and to the children who learn. Education for social adjustment and for efficiency implies education for social economy and for purposes true to the higher spiritual nature of humanity and the upward progress of civilization. The eager acquisitive scramble for material goods in large excess of real needs and even of reasonable demands should be checked, or at least moderated, by restraints of social justice and controls of social legislation.

Social we are in body and mind, rooted in our inheritance from past society, dependent in manifold ways on present society, sowing and tilling not only for ourselves but for our

[1] Professor E. C. Jeffrey in the last chapter of his book, *Coal and Civilization* (1925), bases on other authority a more optimistic outlook for a much longer future.

offspring, for future society. Should we not then learn to be truly social, to know better and to love better not only our own families but the communities in which we live in ever widening circles of kinship and interest? For in a larger sense are not they too our own, and have we not relations of interdependence with them and duties to them that are with each access of social conscience becoming more definite and more real? Should we not know more about these social relations, and should we not face our social duties more unselfishly? All this does not mean socialism in the narrower sense in which it is so much disliked by individualism. It simply recognizes the scientific and ethical truth that self can neither be developed apart nor dissevered from society.

For lack of social knowledge and of coöperation in applying it the world of social humanity has drifted into desperate straits. If the teachers and leaders of men had more clearly known the coasts of human nature and more wisely considered the currents of social and economic forces, the educational and humanitarian purposes with which they confidently embarked in the dawn of the twentieth century would probably not now be imperiled in dangerous waters and in the swirling tides of insurgent peoples. If the consequences of individualism, of industrialism, of nationalism, of militarism, and of war had been foreknown, not merely by the few, but by the many, and if the words of those who singly foresaw had been socially heeded, the sinister events of the preceding decade would probably have been averted, the history of Europe would have been spared its most devastating tragedy, and the edifices of our civilization would not have been shaken to their foundations. We might indeed have progressed more steadily and more rationally to the essential socialization of our economic, political, juridical, and educational systems. The evils under which humanity suffers were not, let us believe, inevitable; and the disordered conditions under which the peoples are striving are not, let us hope, irremediable.

But recent progress in social-economic organization and in the organization of social knowledge has, compared with the past, been manifestly rapid and reassuring.

Knowledge, it is true, has not yet saved the world, — for men shall not live by knowledge alone. Social man, however, is more purposively socializing and "humanizing" knowledge in relation to other motives of human mentality, especially the imaginative and the emotional, the religious and the æsthetic. This is an adaptation of the utmost importance. With it has dawned an era of coöperative application of organized knowledge and of wider diffusion of social intelligence; and consequent upon it should be a sounder training of imaginative tendencies and a saner control of emotional expressions. If this is not saving the soul of humanity, it is at least a very inspiriting advance toward that consummation.

Literature is replete with encomiums of knowledge.[2] It is by knowledge and reason that man is superior to the brutes. By knowledge and reason he has subdued to his needs even forces of nature in the presence of which primitive man stood helpless and awe-stricken. In the ascent of humanity the value of knowledge and education is paramount. This is true of the past, and the truth is well recognized. It is probably truer of the future. Practical men have in a hundred ways learned to appreciate the values of science and education.

It is indeed evident that the welfare and progress of humanity largely depend on completer, more effectual organization of science and technology, as well as on better socialized education, ameliorative social ethics, and remedial social legislation, all resting on organized knowledge. "If human society is to be something more than an aggregation of individuals, if it is to accomplish more than can be performed

[2] From the *Prometheus Bound* of Æschylus (second episode) to Professor Frederick Barry's recent book on *The Scientific Habit of Thought* (pp. 298–300) this is a noble succession.

by separate persons, it must be through higher and higher organization, that is, through greater specialization and more complete coöperation. There is no doubt that the evolution of human society has been in this direction, and the entire past history of living things indicates that further progress of society must be along this line." [3] Human life, biologically organic and mentally social, must also be socially organized on a basis of organized knowledge.

2. INDIVIDUALISM, FREEDOM, AND PROGRESS.

The relations of individuals and societies are in general reciprocal. Social organization is rapidly progressing. Radical socialism, however, demands too drastic reorganization, while on the other hand extreme individualism tends to lawlessness and anarchy. The best freedom subsists under social restraints; but the social organization should not be too rigid and conservative. If progressive and liberal, it will be accepted by the rising generation. Education should serve these interests. Social organization should be consistent with well organized knowledge, but it should be adaptive and progressive.

Two opposing views regarding the relations of the individual to society are here envisaged. The "rights" and "interests" of individuals are contrasted with the rules and compulsions of societies; and this contrast is presented in different analogies in literature, in philosophy, in social legislation, and in business principles. In terms of biological organization the antithesis is well characterized by Edwin Björkman in his book entitled *Voices of Tomorrow;* and the passage is quoted here as being especially consistent with the analogies of our argument.

"Individualism emphasizes the cellular construction of all society, and the dependence of social welfare on the free development of each cell, that is, of the individual. Socialism prefers to accentuate the visible and the invisible connections that bind all the cells together into a larger unit and that render their individual welfare dependent on the harmonious development of the social organism in its entirety."

[3] Conklin, Edwin G., *The Direction of Human Evolution,* p. 89. This is the view of a biologist. A sociologist's carefully reasoned conclusions with similar bearings are set forth in certain chapters of Prof. R. M. MacIver's *Community,* (London, 1924), especially in Book I, Chapter II, Book II, Chapter II, and Book III, Chapters I, III, VI, and VII.

It is implied in this and in all valid statements of the antithesis that the individual is inseparable from society, that individual interests are everywhere involved in social interests, and that the two contrasted sides are not really opposed but are component in the complex fabric of human life; that the opposition is apparent only on viewing the fabric now from the one side and then from the other.[4]

More concretely the antithesis between social-economic industrial organization and individualistic, competitive business in a snarled, unorganized society is expressed in a remarkably incisive manner in the following passages from Ernest Poole's thought-stirring novel, *The Harbor:*

"That's what we mean nowadays by a port, . . . a complicated industrial organ, the heart of a country's circulation, pumping in and out its millions of tons of traffic as quickly and cheaply as possible. That's efficiency, scientific management, or just plain engineering, whatever you want to call it. But it's got to be done for us all in a plan instead of each for himself in a blind struggling chaos."

"But against these men of the tower, with their wide deliberate views ahead, embracing and binding together not only this port but the whole western world depending on it, I found in the city jungle innumerable petty men, who could see only their own narrow interests of today, and who fought blindly any change for a tomorrow. . . . They were hopelessly used to fighting each other . . . all these men belonged to a generation gone by, to the age of individual strife that my father had lived and worked in — and like him they were all soon to be swept to one side. . . ."

These two apparently opposing tendencies have never before seemed so intensely active as at present, especially in their extreme and radical developments. Social organi-

[4] Professor MacIver gives a commendable criticism of the fallacious organism analogy (*Op. cit.*, pp. 72–6): "A community is not a constructed organization, it is a life. . . . Community is not an organic, it is a spiritual unity." That sociality and individuality are inseparably interrelated, or correlated, he subsequently affirms to be the fundamental principle of social or communal development. (pp. 219–20 and 224–31). Charles Horton Cooley in his *Human Nature and the Social Order* clearly shows the closeness of the relations (revised ed., pp. 35–43), as also James M. Baldwin thruout his estimable book, *The Individual and Society.*

zation in many fields of interest and activity is progressing with unprecedented rapidity. On the other hand, lawlessness threatens to disorganize social institutions long sustained by the great classes that depend on law and order. Selfishness and self-assertion have always forcefully existed; but in recent years certain strident individualists have more perversely propagated modes of thought and conduct which in the various occupations and entertainments of human life, and in their heedless wastes, have become very difficult to control by law or morality or any appeal to prudence or fear or love. Such influences have extended in all directions. Some of them we call radical, some we regard as immoral, some are positively lawless, and some are just idiosyncratic. By their advocates their principles are defended in the name of personal liberty. But personal liberty to do as one pleases in all things may extend to crimes; it may tend to become not only personal liberty to get drunk and to break the law, if it prohibit, but to steal a man's purse, or his home, or his wife, and to kill him, if he oppose.

Upon the menace of lawlessness in the minds not only of the young but of the old our more courageous ministers and occasionally our statesmen stand up before us with warning emphasis. Individualism, fostered by excess of freedom, tends in its extreme to issue in outrageous anarchy.

On the other hand radical socialism has not only challenged the rights of individual freedom and personal property but has threatened the existent and developing social institutions as being, in that view, fundamentally inadequate, incorrigibly pernicious, and obdurately unjust.

Freedom, of course, is not merely the state of individuality untrammeled by social restraints and obligations. There is freedom as well in social relations, even where regulated; and truly it is social freedom that is most estimable. Indeed, society is a medium for overcoming the biological limitations of individual life in a natural state. Robinson Crusoe was free as an individual without society, but he was a prisoner in the

bonds of nature. If nature had supplied every physical need, his most positive human want would still have been society, tho that implies the constraints of custom and of law.

Somewhere between the extremes of state socialism and individualism will develop the true freedom in the well organized society. Organization should not too narrowly restrict individual activity and initiative, not too rigidly hinder changes, nor debar novelties, nor resist diversions. Under changeless conditions the tissues of life stagnate. In no immutable organization should human society be embodied, but in a system of organic relations, vital and mental, economic and politic, ethic and æsthetic, all well rooted in the past and adaptively expanding into the future.[5]

Certain social and political aspects of the liberal state are engagingly previsioned in Ramsay Muir's little book *Politics and Progress,* from which the following is quoted:

"It will be a very different society from the rigid, static, regimented society which the Socialist imagines. It will be very different, also, from the society of to-day, with which the Conservative is so nearly content. But, unlike the Socialist State, it will have grown by a natural process out of the society we know, without any violent upheaval; and it will be linked with it by a continuity of tradition and of general character." (p. 20)

"Whatever blunders we may be guilty of, we must never think of the Liberal State as if it were an isolated unit whose organization can be planned without reference to the complex world-society of which it is a member." (p. 28)

"Of the three broad conditions which we have laid down, the first two — the better distribution of the product of industry, and the provision of adequate security for the worker — cover the points at which Liberalism is most likely to come into conflict with Conservatism; the third — the encouragement of private enterprise — covers the points on which Liberalism will necessarily come into conflict with Socialist Labourism." (p. 44)

If social organization be truly progressive, there is less ground for radical arguments. Rational progress may seem slow; but on the other hand radical change may prove dis-

[5] Professor Cooley's *Human Nature and the Social Order* (Chapter XII, "Freedom") and his *Social Organization* (Chapters XXIX and XXX) furnish some good reading on these topics.

astrous, and, as history has repeatedly shown, may produce almost equal reaction. Even at the greater cost no more would then be gained. Reorganization therefore should be moderate and adaptable to the transitional conditions; it moreover should be willed by or acceptable to the communities involved; and it should withal be based on well organized knowledge.

One of the most significant reactions produced by the consequences of the great war is that sometimes termed "rationalization", which has become an important movement in most of the countries of Europe, at least in the industrial and the educational classes. Rationalization would apply organized knowledge and reason to economic and industrial as well as to social and political affairs, which have too much been ruled by unreasoned empiricism, custom, and arbitrary authority. In industry and technology especially organized knowledge is being applied coöperatively, and increasingly, to *test*, select, and *specify* materials, commodities, and services, both as to quantity and to quality, to *standardize* methods, products, and parts, and to *simplify practice* and processes, styles, and merchandising. This movement has its counterpart in America; it tends to become comprehensive and international. But rationalization, simplification, and standardization should not — as is feared by individualists — be allowed to formulate and establish mediocrity without liberal regard for variety, distinction, novelty, and progress. "Standardization is dynamic, not static," proclaims the motto on the title-page of the *Year-book* of the American Engineering Standards Committee for 1928. "It means, not to stand still, but to move *forward* together."

Since progressive organization largely depends on unconservative youth, we may well raise the important question how young life at present regards conformity and regulation. To the older generation it is disconcertingly apparent that the younger generation conforms less and less to tradition and convention and more and more to the novel and diver-

gent fashions so attractively advertised. This tendency to diverge is sometimes called the *insurgence* of youth. Into the dominant social and industrial systems, however, youth heartily enters, even glorying in their splendors. These two tendencies may be turned by well directed education into the channels of progress and organization. Youth will accept the organization, if youth believes it to be progressive and not too oppressive to freedom.

This social situation was discussed judiciously and liberally by Stuart P. Sherman in two of his delightful and edifying books, *The Genius of America: studies in behalf of the younger generation,* and *My Dear Cornelia,* in chapters which their appreciative readers may recall. Cornelia's children have broken away from the traditional culture and morality, which she so beautifully expresses, but they are too sane in their natural endowment to be seduced by the licentious tendencies and perverted by the bizarre tastes that they see running wild in their environment. They heed and are influenced by the liberal Professor, whom they take into their confidence (Book V). Another book, *The Challenge of Youth,* by Alfred E. Stearns, Principal of Phillips-Andover Academy, sympathetic with youth, idealizing youth's ideals and motives, pleaded for a saner, more moral, and more religious life. The errors of the past generation, said Mr. Stearns, have issued in a disordered, demoralized situation, and our culture and civilization are indeed threatened.[6]

Freedom, self-expression, and even insurgence are vibrant echoes caught up by alert sensibilities from the arts and literatures, the plays, the daily papers, and the almost daily picture plays. These should be restrained, not by a rigid

[6] For aspects of certain moral, educational, and social problems, *The Revolt of Modern Youth,* by Judge Ben Lindsey and Wainwright Evans, should be mentioned here. On the relation of progressive youth to organization Professor Cooley's opinions may be consulted in his *Social Organization,* p. 274. The intellectual outlook of the new scientific humanism and the relation of the mind of youth to the liberal, progressive professor are viewed from a high educational plane in Frederick Barry's book (cited above), pp. 300–16.

censorship, but by the expressions of a moderately liberal code of morals, and by sanctions and enforceable laws conforming to those morals and to adaptive social criteria resting on sound judgments and sane æsthetic tastes.

It sometimes seems that youth has broken loose from all our restraints, that our slower feet fail to overtake it, and that it would resist our compulsion. This to some seems less a revolt than a liberation, a departure of the new life from the old. Casting off the time-worn codes of custom, of morality, and even of law, has not the young brain swung out too far in freedom and become giddy in its gyrations? But by educational forces it shall be brought within bounds. By social compulsion it will be made to submit self to society, to the social will as embodied in social organization, in institutions, and in ethical norms.

In a transition stage the past and the future, tho apparently incompatible, inevitably coalesce. In the educational field there is especial need that the contacts between the younger generation and the minds of mature men and women should be at once informative and vital. Educational systems should adapt their methods and curricula to the new tendencies and the changing conditions. The studies of child psychology and social psychology are indeed prodædeutic to the philosophy of education.

Progress not only in mental but in social organization is here affirmed. Underlying all the changes and conflicts, movements and reactions, advances and reversions, and also superposed on them, there is a net gain, an amelioration, a spiritual as well as a material progress. This belief may be regarded as affected by ethical or religious predilections, but it has the cumulative support of scientific and of philosophic reasoning.[7]

[7] The excellent little book, *The Living Past,* by F. S. Marvin, is recommended to those who may desire a historical survey of social and intellectual progress as determined by the coherent purposes of the human spirit. The conditions and the criteria of social or communal development are surveyed in MacIver's book (*Op. cit.*, Book III, Chapters I, VI, VII, and VIII).

As modern life strides into the future, organization becomes more and more essential. This truth is seen, tho from divergent points of view, by both the old and the young, and in both the tendencies toward organization are strongly operative. The conservative classes, the older *archies* and *ocracies,* having acquired personality and property, organize to secure their possessions. The eager throngs of youth, where many *isms* come together, collectively are seeking reality and their heart's desire. From collectivism to social organization may seem a long march, but it is on a road that youth treads as to the land of promise.

Young life bled to free the world for democracy, or at least for some more liberal dispensation. But young life lives to work out its cherished purposes despite the burden of half-ruined structures it has inherited and still must inhabit. *Reconstruction* in many fields, political, social, economic, and scientific, is in progress. The new construction must utilize the old materials, however new the tools; and the old structures, where adaptable, must be reorganized to function in developing systems. The imperishable foundations in human nature change more slowly than social institutions. For the sake of coöperation and solidarity there must be compromise with conservatism. Radicalism and conservatism are moderated and merged in progressive liberal reorganization.

3. FUNCTIONAL ORGANIZATION AND PURPOSE.

Each social interest should be organized. Functional organization is distinguished from structural, and organization of will and purpose from organization of knowledge and thought. The purposes of functional social organizations may be effectuated thru social compulsion. From the simpler organizations develop the more complex. The social world is a complex system of systems, which, however, at present lacks efficiency even as it lacks concord. As industrialism has supplanted militarism, liberal social economy should prevail over oppressive industrialism. Amelioration depends on the organization of knowledge and purpose. World-wide international coöperation and organization are contemplated.

An organization is not merely a system of organic parts, of components and relations, but it is also *functionally* an interaction of forces, activities, and purposes. The organiza-

tion of purpose should become what has also been termed the organization of will and of effort. "The process by which a group will is arrived at may be termed the *organization of will*. . . . In an army, a railroad, a government department, and a municipal service, we see only organization of effort. In a church framing its creed, a party drawing up its declaration of principles, a Futurist group hammering out its manifesto, a gild standardizing mercantile usage, and a labor union passing upon a trade agreement, we see only *organization of will*." [8] This communal or collective will should apply the relevant organized knowledge and thought to assist its purpose and effort. England's great effort against Germany in the World War showed this process in extraordinary development. More localized or specialized, it is exemplified also in such movements as those for conserving bird-life, for simplified spelling, and for improving the "movies".

The process is not so simple that its stages may be definitely characterized, but as more or less successively dependent we may distinguish the organization of experience, the organization of knowledge, the organization of thought, the organization of will, purpose, or effort, the consensus of communal minds and of public opinion, the consensus of scientific minds, and the consensus of educational, moral, and institutional minds. For brevity we shall recurrently refer to *the scientific and educational consensus*.

In John Dewey's book, *How We Think*, (Chapter IV), the relation of learning to experience and of thinking to interest is regarded as of vital importance in the "instrumental" development of knowledge and intelligence. Mere information, which may be neither coherent nor instrumental (available or applicable), is there distinguished from wisdom, which is relevant to experience, to conduct, and to discerning and comprehensive intelligence. The organization of experience and knowledge is thus interrelated with the organization of thought and intelligence. The relations of organized experience, knowledge, and thought to meanings and to judgments, also to ideas and concepts, are discussed in the same book (Chapters VIII and IX, especially pp. 108 and 120).

[8] Ross, Edward A., in *American Journal of Sociology*, v. 22, pp. 145–6.

The organization of experience is distinguished by Hobhouse (*Mind in Evolution,* p. 309) in the following terms: " . . . in traditional morality, custom, and law, in social organization, in the technical arts, in science, in religion, and even indirectly in imaginative art — human experience organizes itself into systems governing human conduct. Past experience, including now the accumulated tradition of the race, is used in an organized form in guiding conduct."

Psychological synthesis or organization of experience is analyzed in considerable detail in Bentley's *Foundations of Psychology,* Book II.

On the organization of thought the following passage from Ross may well be quoted: "No pyramid or cathedral embodies the labors of so many generations of artificers as the science, let us say, of astronomy. The Common Law, the Yogi philosophy of India, or a matured branch like physics constitutes a well-knit system, and yet no one head, or even score of heads, can claim the credit of so much logic. Somehow the thinking of many men has resulted in a whole composed of congruous elements fitted together. . . . The process of thus articulating ideas may be termed 'the organization of thought'." [9]

Cooley's *Social Organization* (Chapter XII) discussed analytically the organization of thought and public opinion. Graham Wallas distinguished between the organization of thought and the organization of will, but found them often combined (*The Great Society,* pp. 238 ff.) In his later book, *Our Social Heritage,* he shows the importance of the organization of experience or tradition (Chapter I), and of purpose or interest. (See the chapters on "Professionalism" and on "World Coöperation").

Generally, wherever there is a community of minds, or of interests, or an association of workers or of purposes, there should be a *functional* organization. For this there should be some structure, which would tend to become more definite and more complex as the function or activity develops; and this makes for efficiency.

The term *functional organization* is sometimes applicable even to groups, social or political, to gangs of workmen, or to bands of hunters, or of robbers.[10]

One of the simplest forms of functional social organiza-

[9] *Loc. cit.,* p. 306.

[10] For more adequate analysis the reader may consult Knight Dunlap's *Social Psychology,* Chapters V and VII, and especially pp. 131–2, 199, and 230-1.

tion is a club, or society (in the narrow sense). A business concern also tends to become a functional organization. Both these kinds have some structure, of departments, offices, or committees, with more or less distinct and permanent features, and to these correspond similarly distinct functions. Within the organizations there is division of labor and specialization. Externally relations to other groups or interests are discovered or assumed. These may combine to form more complex and extensive systems.

From the simpler forms of organized experience, knowledge, and purpose have developed the more complicated and extensive systems and functions of scientific and technical, educational and economic, political and governmental organization, from the local societies to the international associations, from special conventions to bureaus of special services, from a manufactory to a corporate national industry, from a committee of a legislature to the League of Nations.

In so far as these extensive organizations embody the consensus of opinion and the interests of their members, they represent correspondingly large bodies of knowledge, thought, and purpose. Their principles and promulgations, their rules and laws, are therefore proportionately effectual or enforceable. A social organization, whether great or small, founded on principles and purposes sustained by a consensus, tends to hold together by virtue of interest in and loyalty to those principles and purposes, even while they are adapted to progressive change; and moreover such an organization, on purposing a change, is enabled to control dissident minorities and even to coerce recalcitrant members. The principles, forms, and morals having been adopted by the community, the precepts, rules, and laws in which they are expressed are rendered effectual through social sanctions and are enforced by social compulsions in established institutions or agencies, especially the family, the school, the church, the legislature, and the court. Organization thus

may be either relatively conservative or progressive; and thus successive reorganization becomes feasible and effectual.

In the great diaphanous sphere of life are wheels within wheels, some moving this way, some that way, some motionless; and lesser globes are rolling about, sometimes coalescing, sometimes bursting into rotary fragments. Is the whole articulate? Does it work efficiently and harmoniously? "Why does it not?" asks Alice in wonder; "why does it creak so, and why are the wheels moving every-which-way, and why do the little bubbles boil so wildly? Why haven't you sent for the mechanic? Oh! I see, you are looking for him. But I think the mechanic must be in there now, working at it tho hidden from us; and I hope he will get it all fixed."

Is the mazy, hazy sphere going to clear up and the imperfect world going to get itself together and work and be happy? This is simple language for the great problems of science and philosophy, involving our history, our ethics, and our religion. Tho the problems indeed remain for science to solve, those questions are answered affirmatively by our faith in God and in man.

The world's mechanism has not worked well because too often some irate mechanic has thrown his monkey-wrench into the works. Because of some wicked individualist, a mad king or queen, a vicious courtier or courtesan, the nations have jarred and jammed in warfare; and the hatreds of fighting men have been engendered, and have been handed down in tradition. For protection against feuds in the medieval era the clans entered the bonds of feudalism. Chivalry in manhood then protected clinging womanhood, which admired the prowess of knighthood. Out of these hatreds and fears, ambitions and fascinations, bonds and loyalties, the monarchs reared militarism. But meanwhile the workers built up their guilds, and later the merchants their competitive organizations. The last century of invention and industrial development has issued in an era of industrialism that

has maintained and has been extended by militarism, but which has now turned on its tyrant and has, we may hope, overthrown militarism, and soon will disarm it. Humanity, however, now faces the problems of moderating this industrialism to the intrinsic values of human life and of subordinating the nationalism that has crowned the ascendencies of militarism to the completer international coöperation in which the now expanding social and economic organizations should attain their consummation.

If nationalism, the proper counterpart of patriotism, had sensed the dangers inherent in the militant competition of commercial interests, that great organizing force would not have been misguided by national ambitions, nor indeed by the military ambitions of its rulers, into the insensate career of competitive militarism. If individualism had realized that without coöperation the splendid structures reared under its régime could not long be sustained, the contentions that now in the name of socialism beset its vested rights would probably be less radical and social-economic reorganization would be more rational.

Where there are such marvelous vital organisms as a healthy body, or a well-developed brain, where such admirable human organizations exist as a telephone system, or a postal service, or a fire protection service, a railway system, a department store, or an automobile factory, where wheels within wheels move so steadily and efficiently, there must be ground for even larger expectations from the organizing tendencies of human knowledge and purpose. And it is quite reasonable to believe that in social, as in biological evolution, the process will become accelerated as it attains to higher stages of functional comprehension.

Science and philosophy, art and literature have for centuries been regarded as international, or rather as *supernational*. In these fields knowledge, thought, and imagination have, despite the difficulties of language, been free from the trammels of nationality. Why should not the main eco-

nomic and politic relations also be at least adjustable to some peaceable and coöperative *modus vivendi* among the civilized peoples, some supernational system of laws and morals, conventions and defences, compacts and covenants? And may not such an international society be furthermore socialized in more purposive organization and in progressive reorganization?

4. GREAT FAILURES AND GREAT HOPES.

Recent international conferences would have been more effectual if the statesmen had been less nationalistic. Those on limitation of armaments have raised hopes not yet realized. But the League of Nations, however imperfect, is a stable organization commencing to function to good purpose. With its subsidiary organizations and its filiation of international organizations, it purposes a comprehensive organization of organizations.

With good foresight the government of the United States, soon after entering into the great war with purpose to gain an ameliorative settlement of intolerable conditions, appointed a corps of prominent professional men to collect, systematize, and render available such knowledge, historical, geographical, ethnographical, sociological, political, and economic, as might have bearing on the manifold questions that must be considered in any attempt to adjust the complicated affairs of desperately war-stricken Europe.[11] That this service was not more successful shows how such organization of knowledge and purpose may be contravened by disorganization resulting from lack of coöperation on the part of those interested. More might indeed have been attained if certain statesmen had been less averse diplomatically to the subordination of national interests to international exigencies.

Then, when the great treaty, however unsatisfactory, was at last concluded and the almost exhausted world was anxiously awaiting its ratification, what an immensely tragic spectacle was presented of crucial lack of coöperation among governments and partizan political groups. The action of

[11] In the book entitled *What Really Happened at Paris,* edited by Edward M. House and Charles Seymour (1921), the first chapter, "Preparations for Peace", by Sidney E. Mezes, then President of the College of the City of New York and Director of the Commission, described this "Inquiry".

one historic committee seemed unconscionably like throwing the monkey-wrench into the machinery. The resulting stagnation seemed like the palustrine geologic age in which the ponderous herbivorous saurians succumbed to the rapacious carnivores before the advent of rational humanity.[12]

More progressive and more coöperative have been the subsequent conferences on the limitation of armaments and on important economic questions. The resulting agreements, however short they may have fallen of the hopes raised in anticipation, must indeed be deemed momentous. An earlier conference of governments at Genoa, of professed economic purpose, would probably have reached judicious conclusions, had it not been wrecked by political snags like those that almost stranded the Peace at Versailles.

The League of Nations, however imperfect and as yet ineffectual, however criticised and repudiated, has still been a great step forward, and its high hopes are progressively being realized; it has become an established organization both structural and functional, and it seems destined, if present tendencies prevail, to consolidate a preponderating organization of international and supernatural interests and purposes. Fifty-five nations, or more, have entered into it. Its chief weakness has resulted from the recalcitrance of the United States. The absence of certain other nations has furthermore impaired its completeness and unity. It has failed to enforce its purposes in important matters and in certain emergencies it has not acted effectually, yet it has accomplished much in the way of determining policies and arbitrating claims, and also in the way of subsidiary organization.

The purposes of the League, "to promote international coöperation and to achieve international peace and security", are not merely political but also social and economic. Its Assembly, consisting of delegates of all member states, is its legislative and ad-

[12] For judicious views regarding Europe's recovery from the war the reader may consult an article by Frank Simonds in *The Review of Reviews,* June, 1928, especially pp. 591–3.

visory body; its Council, composed of representatives of certain member states "acting on behalf of the entire membership", is the executive body. The Secretariat serves the Assembly and the Council, and also "bodies called into being by their resolutions", and consists of nearly five hundred persons, organized in a dozen or more sections and commissions for general administrative purposes or for special "spheres of activity". The League has also organized several commissions or committees, permanent or temporary, for more special purposes, the most important being the Permanent Court of International Justice.

The International Labor Organization, established by the Treaty of Peace, is not just subsidiary to the League but cognate and coördinate with it. This organization consists of: (1) a General Conference of representatives of the member nations, four for each member, two being for the government, one for the employers, and one for the workmen, — this Conference to meet at least once a year; and (2) an International Labor Office, served by a permanent secretariat and controlled by a Governing Body consisting of 24 representatives, including a Chairman and two Vice-chairmen. Twelve of these representatives are nominated to represent twelve governments, eight being of "chief industrial importance". There are also six representatives of the workmen of any six nations. "The functions of the International Labour Office shall include the collection and distribution of information on all subjects relating to the international adjustment of conditions of industrial life and labour, and particularly the examination of subjects which it is proposed to bring before the Conference with a view to the conclusion of international conventions, and the conduct of such special investigations as may be ordered by the Conference. . . . Moreover, it is evident that in all cases where the Covenant requires from the League the execution of duties necessitating preparatory work and technical investigation, every action must be based on documentation prepared by the Secretariat and its experts."

To carry out the resolutions of the recent International Economic Conference the League has established a special economic Commission, in which persons (including Americans) prominent in industry, agriculture, commerce and finance will be invited to participate.

These organizations purpose to function largely by obtaining information and setting it forth in conference and publication — that is, they are concerned with the organization of knowledge, thought, and purpose. Furthermore, the organization of the League of Nations, together with its subsidiary organizations, purposes to consolidate, at least in

their broader relations and interests, all international organizations existent and prospective.

The Covenant provides that: "There shall be placed under the direction of the League all international bureaux already established by general treaties if the parties to such treaties consent. All such international bureaux and all commissions for the regulation of matters of international interest hereafter constituted shall be placed under the direction of the League. In all matters of international interest which are regulated by general conventions the Secretariat of the League shall . . . collect and distribute all relevant information and shall render any other assistance which may be necessary or desirable. . . . the authority exercised by the League will, in reality, be confined to giving the Bureau the moral support which attaches to official affiliation to the League, except in cases where abuses are revealed, . . . " And further on: "It must be assumed that the bureaux, on their side, will be ready to afford the League all possible assistance and information within their special spheres."

One of the sections of the Secretariat is that for International Bureaux. ". . . the Section has given the widest possible interpretation to the term 'international bureau' by considering not only bureaux strictly so-called, but also associations, commissions, congresses, unions, etc., which possess a permanent organization or at least hold periodical meetings. The League of Nations can, of course, deal only with institutions which have no private ends to serve and have no commercial object in view."

This comprehensive structural organization has only commenced to function, but it gives earnest of becoming in the near future more effectual than most governmental organizations. Its efficiency will of necessity depend in detail on the efficiency of the subsidiary and affiliated organizations. And these as international will depend in certain respects on the coöperation of the several national and corporate bodies that are contributory.

The Carnegie Endowment for International Peace is organized in three divisions: of Intercourse and Education, of International Law, and of Economics and History. It also has its specialized library and information service. It is a very effectual functional organization of knowledge, thought, and purpose. The work of the affiliated American Associa-

tion for International Conciliation has been merged with that of the Division of Intercourse and Education of the Endowment. The Institute of International Education, established under the auspices of the Endowment, was for the first three years of its service supported by the funds of the same division, tho it is administered as a separate organization. It is now supported by the Carnegie Corporation and its service continues "under the jurisdiction of the Carnegie Foundation for the Advancement of Teaching," these two being kindred organizations of very liberal purposes.[13]

The World Peace Foundation, founded by the late Edwin Ginn, the well known educational publisher, "is constituted for the purpose of educating the people of all nations to a full knowledge of the waste and destructiveness of war, its evil effects on present social conditions and on the well-being of future generations, and to promote international justice and brotherhood of man; and, generally, by every practical means to promote peace and good will among all mankind." Its pamphlets are widely distributed among educational institutions, and it acts as American agent for the publications of the League of Nations and the subsidiary organizations of the League. It has become a center of information and documentation on international affairs and relations.

In Johns Hopkins University the Page School of International Relations purposes to organize research into the problems, conditions, and means of attaining international peace. For instance, a specific investigation into war profiteering as a cause of war has been undertaken.

The International Institute of Agriculture, located at Rome, has been rendering services of inestimable value. Its work is divided among four bureaux: (1) that of the Secretary-general manages the business, the correspondence, and the finance, the building and equipment, the library and bibliography, and the printing and distribution of the publications; (2) that of Statistics collects and publishes statistics

[13] *International Conciliation,* July, 1924, p. 212.

of agricultural products and commerce; (3) the Bureau of Agricultural Intelligence and Plant Diseases covers what its name implies; (4) the Bureau of Economic and Social Intelligence gathers and publishes information regarding cooperation, insurance, credit, and the socialization of rural communities.

Great hopes have been entertained for the success of these projects, and some have been greatly successful. Others that have succeeded will be mentioned in the next chapter. If others for which highest hopes have sprung seem from their very unsuccess to have been great failures, it may be that we have expected large results too soon. Some of the greatest things grow slowly. Setbacks and retrogressions are likely to retard the progress of ameliorative movements in the surging currents of the still disorganized welter of individual, clan, and class, radical running against conservative, intellectual jostling fundamentalist, criminal assaulting citizen, pessimist overbearing optimist. Yet dominant progress in terms of valid human values is evident, and is measured, or recorded, for those who can and will see these evidences and accept those values. If humanity has as yet failed to disarm the militant, to eradicate the criminal, to prohibit the bootlegger, to segregate the vicious, to suppress the prostitute, and to exterminate the pestilential, society has indeed, even in these persistent social problems and even thru very imperfect organization, consolidated great gains; and for the future thru completer coöperation and social organization, inter-trade, inter-class, interstate, international, thru eugenics, education, sanitation, segregation, and socialization, thru woman's sisterhood and man's brotherhood, society may judiciously harbor immensely greater hopes and purposes. All of these organizations of will and purpose must largely depend on progressive functional organizations of relevant thought arising from verified, synthetic knowledge.

CHAPTER II

PROGRESS TOWARD COMPLETER ORGANIZATION.

1. SOCIAL, POLITICAL, AND ECONOMIC ORGANIZATIONS.

Developments in functional organization are manifest in many fields, in agriculture, in economics, in banking and in business, in consumers' and in producers' coöperation, in civic and community organization, in art, in dramatic and motion-picture interests, in legislation and litigation.

There are innumerable organizations functioning in all kinds of interests, economic, commercial, and professional, social, educational, and scientific, national, international, and local, some for research, some for amelioration of conditions, and some for development, control, or promotion of interests involved. In the following pages a few important and representative organizations will be mentioned without attempting a systematic account of this vast subject. We would merely substantiate the conclusion that the organization of knowledge, thought, and purpose is rapidly progressing thruout the whole social and economic world and is probably the most significant and momentous development of the present period. And in such organization purpose organizes knowledge and applies it to further the purpose.

In the United States a notable organization of economic interests centers about Babson's Statistical Organization, Incorporated, and the Babson Institute, both founded by Mr. Roger W. Babson, the well-known statistician. The Statistical Organization has for over twenty-five years maintained an important service of information regarding financial, industrial, and commercial conditions, and has collected and organized a great body of knowledge in economic and business interests. The Institute was established

some years ago for educating business men and for gathering and studying information regarding economic conditions thruout the world. Its Educational department offers both resident and extension courses in four main branches: finance, management, production, distribution. The Research department provides for the study of economic and business problems by advanced students and representatives of business concerns. These two organizations and the adjacent Babson Park, which is being developed as a community of business men and organizations in an economic and business research environment, and which is progressing in the structural stage, bid fair to become one of the most important centers in the world for information, research, and education in economic and business interests. Here may develop a great coöperative organization for the systematic compilation, dissemination, and application of relevant knowledge. It serves as an indication of wide-spread tendencies in business and in social economics. In these spheres too there is a consensus of opinion in contact with the scientific and educational consensus.

"To-day business organization is moving strongly toward cooperation. There is in the coöperative great hopes that we can even gain in individuality, equality of opportunity, and an enlarged field for initiative, and at the same time reduce many of the great wastes of over-reckless competition in production and distribution." [1]

The United States Department of Commerce and the Chamber of Commerce of the United States have effectively coöperated in such interests as organizing relations of industrial and financial bodies, economizing production and distribution of commodities, simplifying and standardizing industrial methods and products. In this last interest the American Engineering Standards Committee engaged in valuable coöperative work with *member-bodies,* corporations, and affiliated organizations in specifying and publishing indus-

[1] Hoover, Herbert, *American Individualism,* p. 44.

trial and technological *standards*. More especially the American Society for Testing Materials has coöperated in this rapidly developing system of *specification* and *standardization*.

President Butler of Columbia University in one of his important recent addresses was quoted in the New York *Times* as follows:

"Thus we are all alike feeling the pressure for coöperative economic organization. The system of continental and internal free trade which has built up the United States should point the way and lead the way to other similar organizations and federations, and when that is accomplished, if it is successfully accomplished, our successors a generation or two hence will have the largest and ultimate task of finding a formula for the organization and integration of them all."

There are in the economic field in the United States many other important organizations the activities of which receive almost daily mention in the newspapers, and the publications of which are in frequent use in the larger libraries. The National Industrial Conference Board publishes important Research Reports on such matters as industrial conditions, wages, the cost of living, the hours of work, taxes, revenues, etc. The Bureau of Railway Economics renders similar service for its special field. The American Bankers' Association not only holds important annual conferences but purposes to promote the general welfare by financial measures, to increase the usefulness of banks, to serve convenience by uniformity of practice, to defend against unfavorable or ill-considered laws and to protect banking interests against crime. The Pan American Union and the several Chambers of Commerce in their particular fields promote financial and commercial interests by discussion, by action, and by the pressure of opinion, or influence. The National Association of Credit Men confers as to conditions and cooperates in securing results. The American Manufacturers' Association represents one side of a great opposition of industrial interests. On the other side rears the massive Amer-

ican Federation of Labor, which combines in an immense organization the special and local trades and labor unions, without depriving them of their autonomy.

As an example of an association of manufacturers instituting a service of research and information for its members, the National Canners' Association may be mentioned. Established in 1907, this association soon appreciated the need for organized research and in 1913 established its Research Bureau, or Laboratory, at Washington, where it conducts investigations, extending into several sciences, relative to the canning of foods and their storage, also their composition and their nutritive value. Its work is brought into relation with the respective studies in several universities and in the Bureaus of the Government making similar investigations.

Consumers' coöperation is rapidly extending thruout Europe and is organized nationally and internationally, comprising not only retail trade but wholesale and even manufacture of a wide range of products. The coöperative societies are now, after a period of vicissitude, well established, well organized, and well managed, and in certain European countries they tend to absorb a large part of the trade. Several of the national organizations are not only operating efficiently but they have become economically dominant, particularly in Denmark and in Switzerland, while in England and Scotland progress in that direction is remarkably rapid. Under American conditions the growth is slower, but producers' coöperation in certain industries (especially in farming, fruit-growing, market gardening, and milk supply) has already assumed large proportions and has recently been prominently and even politically advocated. Consumers' cooperation too is well-rooted in certain parts of the country.[2]

A community is a body of people having in common a history and important social and economic interests. In Pro-

[2] For interesting accounts of this vast movement see the books *Coöperative Democracy*, by J. P. Warbasse, *Coöperation the Hope of the Consumer*, by E. P. Harris, and *Denmark*, by F. C. Howe, particularly Chapter V.

fessor MacIver's more philosophical definition: "A community is a social unity whose members recognize as common a sufficiency of interests to allow of the interactivities of common life. . . . Communities must create associations in order to uphold communal interests, associations which pursue those interests in specific ways." [3]

"Community organization is the coördination of all community resources for the solving of community problems." Rural communities have a *community center* in a village or town, in a school or church or town hall. Preliminary to formal organization there may be a *social survey* for gathering data, outlining a plan and program, conducting a publicity campaign, and securing the adoption of the plan by the community.

There are several kinds of survey. The *comprehensive interlocking survey* is an expert, detailed, analytical study of the entire social, economic, industrial, and political structure, notable examples of which are the Pittsburgh Survey in 1907 and the Springfield, Illinois, Survey in 1913, both conducted by The Russell Sage Foundation. These set a high standard of effective organization and accomplishment of results. A social survey should itself have a plan of organization. One form is shown in the diagram on the following page.[4]

In a town of five thousand people a social survey revealed the fact that there were one hundred and eighty-nine organized groups. Outside of the churches there were sixty-three women's and girls' societies; ninety-eight were religious groups; twenty-three were men's business and social, including the Boy Scouts, etc., and five were musical and social. A plan for organization is shown by the diagram on page 33.

The American Civic Association aims to improve cities and urban life by interesting the citizens, informing their committees or commissions, and influencing their officials. The National Municipal League is an affiliated organization that in coöperation with that Association, with the City Managers' Association, and with the National City Planning Conference, publishes quarterly *The National Municipal Review* as their joint organ. This organization exemplifies a wide-spread movement in applying knowledge to ameliorate conditions.

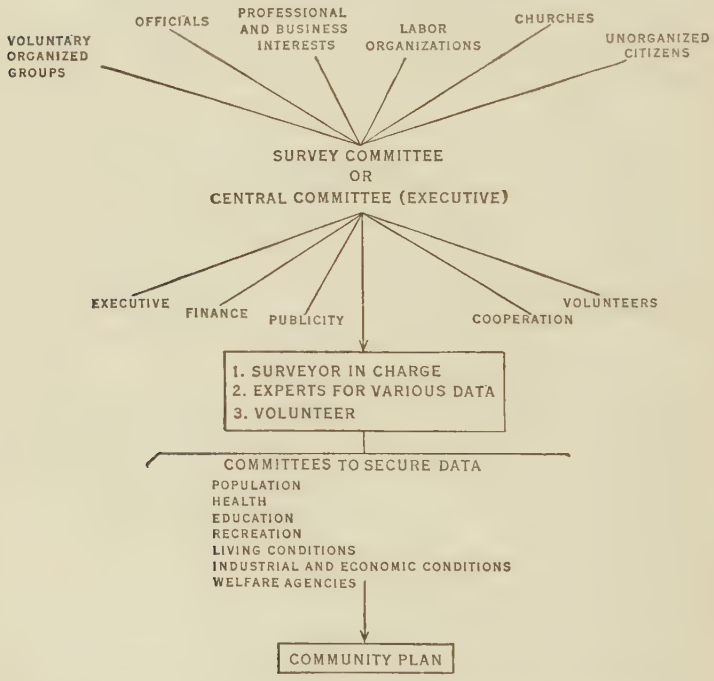
[3] *Op cit.*, pp. 109–10.

[4] The foregoing quotation and the following charts are by permission taken from the book on *Organizing the Community* by B. A. McClenahan, published by the Century Company, of New York, in 1922.

L'Union International des Villes, with headquarters in Brussels, purposes to provide "an international clearing-house of civic information." The International Congress of Administrative Science and the International Parliamentary Union are organizations of "political prudence" based on organizations of political knowledge.

"By political prudence is meant the conclusions of experience and reflection regarding the problems of the race, wisdom that does not reach the state of science, yet has its own significance. This constitutes a body of knowledge which, though not demonstrably and technically exact, is nevertheless a precious asset to the race. It is the wisdom of the elder statesmen and the savants." [5]

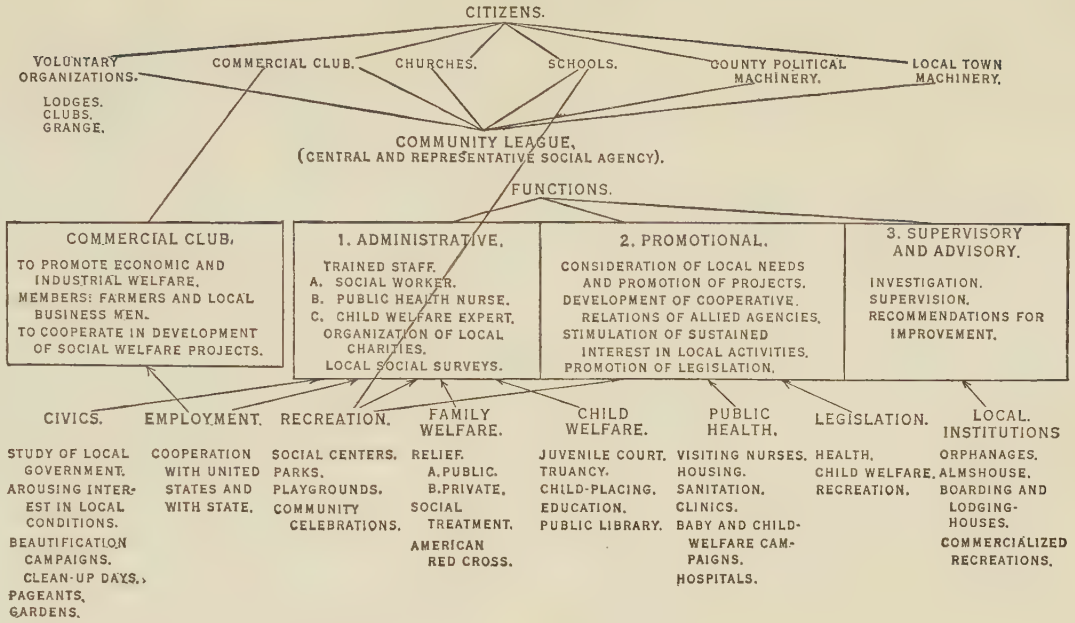
DIAGRAM OF ORGANIZATION FOR A SOCIAL SURVEY



The Institute of Politics in Williamstown is an influential organization of opinion and prudence thru discussion. In Geneva and Vienna somewhat similar groups of men of experience and judgment assemble "for the interchange of ideas and perhaps for

[5] Charles E. Merriam's *New Aspects of Politics*, published in 1925 by The University of Chicago Press, p. 210. Several passages in this section are quoted with permission.

OUTLINE PLAN OF COMMUNITY ORGANIZATION.



the formulation of programs of action." The form of organization varies for such groups, some being forums for dissemination of intelligence, others purposing definite tho not scientific inquiry, still others undertaking scientific research.

"An interesting example of an impartial inquiry was that conducted under the auspices of The National Civic Federation into the public and private operation of public utilities, in 1907. This study was conducted by a board of persons, including utility-owners and operators, representatives of street-car unions, theoretical advocates and opponents of municipal ownership, impartial observors. Two sets of accountants, engineers, investigators, were provided. The results were brought together in an imposing series of documents, and certain important conclusions were reached by a practically unanimous vote. This inquiry still stands, seventeen years afterward, as the best collection of material upon this important problem in American industrial and political life. It is an example of the utility of organizing political prudence in respect to a specific problem."

The National Civil Service Reform League, The National Conference of Social Workers, The National Tax Association, and others, may be instanced as bodies of broader permanent interests dependent on organizations of knowledge, thought, and purpose. These organizations may take the form of statistical compilations, of surveys, of reports, of reviews, and of digests.

"Large numbers of research bureaus are springing up in various parts of the United States and are vigorously attacking the problems of city government, especially on the financial side. These organizations represent in part the organization of prudence and judgment, and in part also are carrying on research of a technical nature, from which genuinely scientific results may follow."

The New York Bureau of Municipal Research and the Westchester County Research Bureau, pioneers in their respective fields of municipal and county interests, have pointed the way in rendering valuable service.

The tendencies in organization of political knowledge may, according to Professor Merriam, be considered under three heads:

1. The development of secondary political education.
2. The organization of adult intelligence and political prudence.
3. The organization of scientific research in government.

Political research may advance in the following steps:

1. The more complete organization of political information.
2. The more complete organization of political observation.
3. The broader use of the instruments of social observation developed thru the census, statistics, and psychology.
4. The synthesis of elements from related sciences into a new politics.

5. The development of experimentation thru controlled political groups.

6. The organization of intensive political research thru governments, universities, foundations, and perhaps institutes of political science.

"There will be far more perfect organization of political information than is found today, and of political observation as well. This lags, but it waits only the touch of interest and organization to catch step with the advance of the modern world. There will be wider organization of the political intelligence and prudence of the time than ever before, not merely local in its scope, but world-wide organization of the opinions of the wise men and the wise women. And this will bring higher levels of tolerance, higher levels of discussion and attainment, wider possibilities of wise decision. Toward this stage of political evolution we seem to be moving with rapidity." (*Op. cit.*, p. 236)

"Jungle politics and laboratory science are incompatible, and they cannot live in the same world. The jungle will seize and use the laboratory, as in the last great war, when the propagandist conscripted the physicist; or the laboratory will master the jungle of human nature and turn its vast, teeming fertility to the higher uses of mankind." (p. 247)

The American Arbitration Association has since 1926 effectually organized on broad coöperative grounds the facilities and services for the very important interests of adjusting disputes in the commercial and professional fields. Industrial and family affairs are expressly excluded. The Association succeeded the Arbitration Society of America, which for some five years had advocated and organized systems of commercial arbitration. For personal and domestic interests the Legal Aid Society has independently and in a smaller way been rendering similar services. The Arbitration Foundation and the Arbitration Conference were also combined in the Association, with which are now associated and affiliated about 450 commercial and trade organizations. The membership, personal and corporate, numbers over a thousand. This association coöperates with the interested departments of government, national and state, with the United States Chamber of Commerce, with the Pan American Union, and with important national organizations, such as the American Bankers' Association, the National Association of Credit Men, and the American Society of Certified Public Accountants, besides the judiciary and the bar associations. It is "recognized as the authoritative national center of information and of coördination of arbitration activities." The wide extension and rapid progress of the movement has fully justified the large undertakings of this highly intelligent and liberally conducted organization of knowledge, thought, and purpose.

To organize the knowledge relevant to its interests is one of the main purposes of the Association. It conducts researches and surveys; it publishes results, an educational literature, and reference books, notably *The Year Book on Commercial Arbitration, The International Year Book on Civil and Commercial Arbitration,* and *The Handbook on Commercial Arbitration.* It also extends an information service, gives advice, and promotes good will.

The actual purpose is to arbitrate cases in the commercial field. For this a system of tribunals is organized, with a panel of arbitrators numbering over 4,500, in some 1,500 cities and towns. These arbitrators serve without compensation, unless by agreement with the parties. Arbitration is usually provided for by contract or agreement, and an "arbitration clause" for insertion in the contracts has been adopted. Entire trades and professions enter into contractual relations. But outsiders too may submit their cases, and lawyers often advise this, or present the cases themselves.

During the past two years about 500 cases have been submitted to the Association's tribunals, and about half of these have been satisfactorily arbitrated, the other half having been settled or withdrawn prior to arbitration. The motion-picture industry has since 1923 successfully arbitrated practically all its internal controversies. Other industries have been adopting the economies, which are so considerable that a very extensive development of the organization is predicted.

The Association's rules for procedure conform to the Arbitration Act of the United States and to that of New York State. Similar laws have been enacted in six other states. One of the Association's main activities at present is promoting effectual legislation in the remaining states, and for this purpose it has prepared a Draft State Arbitration Act. Uniformity of legislation and procedure is especially important to the interests. In states having effective laws the awards of the tribunals are enforceable, even with the coöperation of the courts having jurisdiction.

The movement is extending internationally both in European and in American countries, under the auspices of the International Chamber of Commerce, the League of Nations, and the Pan American Union. The League has expressed its interest in its Protocol on Arbitration Clauses and in the Convention on Enforcement of Foreign Arbitration Awards. The whole movement well exemplifies not only the economy but the good-will value of the coöperative organization of knowledge and purpose.

Successful arbitration depends on clarity in the relevant law. The American Law Institute, an association of foremost jurists and lawyers in the United States, was organized in 1924 "to promote the clarification and simplification of the law, secure better administration of justice, and carry on scientific legal work."

2. ECONOMIC SIMPLIFICATION AND STANDARDIZATION.

Industrial and technological materials, products, methods, and measures are subject to testing, specification, *simplification*, and *standardization*. Hence an important coöperative movement has developed, involving extensive organization corporate and institutional, national and international, and resulting in economies in production and in distribution of products. More broadly standardization extends to scientific measures and constants, to educational methods and curricula, and to social norms and manners. It should extend to social economies and educational services to consumers. Simplification, specification, and standardization imply functional organizations of knowledge.

A coöperative movement of immense importance, which until recently has received comparatively little public notice, has been rapidly developing during the past ten years or more in scientific, technologic, and industrial fields. From scientific *data* are derived *constants* and *units*, measures and formulæ, coöperatively determined and standardized — also atomic weights, specific gravities, densities, melting-points, etc. From technologic tests and investigations industrial and commercial *standards* are coöperatively selected, adopted, and published. Bewildering variety and multiplicity in products and parts, in sizes and grades, in styles and methods, may thus be reduced to comparative simplicity, with resulting economies largely realized.

In broader aspects of American industrial economics *standardization* has for half a century been one of the means of mass production. But *simplification* [6] has been advocated more recently as part of the program of reducing waste in production. First in factories and trades certain materials, products, and processes were tested, specified, and standardized; then industrial and technological standards were adopted by corporations and groups and even nation-wide industries. During the past decade societies and associations, or their committees, have been combining in a system of national and international organizations. These coöperative investigations, determinations, and publications virtually involve functional organizations of knowledge.

[6] Under the terms *rationalization*, *simplification*, and *standardization* this movement was mentioned twice in the preceding chapter.

The first national institution for testing was established in 1887 in Germany, The Physikalisch-technische Reichsanstalt in Charlottenburg, of which the great scientist Helmholtz was the first president. Le Laboratoire Central d'Électricité was founded the next year at Paris. In England the National Physical Laboratory began its services in 1900; and in the United States in 1901 the National Bureau of Standards. In this same year national standardization was first undertaken by the British Engineering Standards Association. But it was not till 1917 that Germany instituted national standardizing in the organization now named Deutscher Normenausschuss. Holland's Centraal Normalisatie Bureau had begun its service in 1916. In France a Commission of Standardization commenced in 1918, but it was not till 1926 that L'Association Française de Normalisation was founded. In the United States the American Engineering Standards Committee was organized in 1918, and in the same year in Switzerland Die Schweizerische Normalien-Vereinigung. L'Association Belge de Standardisation was founded at Brussels in 1919, and in this year too the Canadian Standards Association was chartered. At present (1928) twenty nations have national standardizing organizations.

These national organizations are either maintained by or cooperate with some department of the government. They are cooperative too in their corporate membership, in their relations and affiliations, and in their services; and they coöperate internationally. In the American Standards Association, which has succeeded the American Engineering Standards Committee, 37 organizations are represented, including 7 departments of the Federal government, 9 engineering societies, and 21 industrial associations — all of national scope — and 300 organizations and 2,000 individuals are engaged in the Committee's activities. The British Association has over 500 sectional committees and more than 2,500 members. The German institution has over 100 committees, and nearly all the large firms in the country are actively participating. It has established over 2,100 standards, distributed in nearly every branch of industry. The American Committee has approved over a hundred standards, and over 160 others are in process. The British Association has published over 500 standard specifications, and the French association about 350.

"The growth of simplification and standardization in Europe since the war is nothing short of marvelous, not only from the standpoint of the number of standards actually established and the number in the course of preparation, but also from the standpoint of the number of industries involved and the high quality of the work being performed." [7]

[7] *American Academy of Political and Social Science, Annals,* v. 137, p. 30 (May, 1928). This volume in 37 contributions edited systematically covered the subject in its broad aspects and in considerable detail.

The importance of simplification and standardization was emphasized in the World Economic Conference at Geneva in 1927, which advocated the *rationalization* of industry, defined as including "the scientific organization of labor, standardization of both material and of products, simplification of processes, and improvements in the system of transport and marketing. . . ."

"Its judicious and constant application is calculated to secure: 1. To the community greater stability and a higher standard in the conditions of life. 2. To the consumer lower prices and goods more carefully adapted to general requirements. 3. To the various classes of producers higher and steadier remuneration to be equitably distributed among them." [8]

In the United States the importance of the movement is evinced by the undertaking of a complete survey of standardization activities, which has been projected by the National Industrial Conference Board. "Industrial standardization is making many of the economies of mass production available to all manufacturers of essential commodities, large and small. It is improving processes and products, broadening markets, and aiding distribution and purchase." [9]

The American Society for Testing Materials has a membership of 4,200 (including 400 in foreign countries), individual, corporate, institutional, and municipal. The purpose is "promotion of knowledge of materials of engineering" and "standardization of specifications and methods of testing". This comprises: (1) methods of testing materials, (2) standard definitions and nomenclature, (3) formulation of specifications, (4) recommended practices.

The corporate organization and revision of relevant knowledge in special technologic interests is exemplified in the following "Foreword" to a "Test Code" of the American Society of Mechanical Engineers:

"The Test Code for Reciprocating Steam Engines was one of the group of ten forming the 1915 edition of the A. S. M. E. Power Test Codes. The Society's first complete code for the testing of this type of prime mover was presented and discussed during the Annual Meeting, December, 1902, and was published in the Transactions, vol. 24 (1903). This new Code consists of a complete revision of the 1915 edition. It was printed in preliminary form in the January, 1921, issue of *Mechanical Engineering,* and was presented to the Society during the Spring Meeting held in Chicago, Ill., May, 1921. The Main Committee at its March 6, 1922, meeting approved the Test Code for Reciprocating Steam Engines in its final revised form. At a meeting held in March, 1924, it was approved and adopted by the Council as a standard practice of the

[8] *Loc. cit.,* pp. 25–6.
[9] *American Engineering Standards Committee Yearbook,* 1928, Foreword.

Society. The first edition was exhausted in the summer of 1925. Accordingly, acting under instructions from the Main Committee, Individual Committee No. 5 reconsidered and revised the Code for republication under date of November, 1926. The Council approved this revised Code on December 2, 1926."

But the movement extends beyond the industrial to the social-economic and educational interests. Its scope in the broadest view comprises basic elements of thought and expression, terms, abbreviations, symbols, definitions, measures, units, physical constants, correlated dimensional interrelations, tools and instruments, staple designs, sizes, grades, rates and allowances, in commodities and in services. The various kinds of social and economic occupation, of work and play, of sport and pastime, educational methods, manners, customs, and even tastes, also tend to become standardized. Fashions and styles are but transient standards.

"The trend is toward making standardization an active principle in organization and administration in every field. This is evidenced by the multiplication of standardization agencies organized, including technical committees on standards in the great national professional societies. Standardization is becoming an aspect of all well-ordered activity rather than an incidental activity supplemental to others. . . .

"Research is the vital factor in standardization, chiefly through seven lines of approach: (a) Measuring the need to be met, (b) analysis of factors adapted to meet the need, (c) fixing measured controls for production of predictable quality, (d) basing such controls on correlation of fitness factors with service utility, (e) devising methods of test of quality, (f) analysis of service experience or simulated service to aid in improving the standard, (g) most important — research fundamental to the pure sciences involved. . . .

"No standardization is final since science is always advancing and more effective equipment is steadily introduced into industry. The specification should be improved by steps not too frequent to unduly interrupt the course of industry and trade, but often enough not to lose the great gains from prompt use of new knowledge. Standardization is a continuing process. Its aim is not fixity or stagnation, but to add serviceability as often as the potential gain makes it worth while." [10]

[10] *Standards Yearbook*, 1927, pp. 1, 4, and 6. These passages are from an introduction on "Trend of Standardization" in the first issue of this year-

A standard is a coöperative product approved by a consensus and established by an organization. Standards should, however, be changed to meet new requirements or to apply new knowledge. "A standard must represent the best that industry has to offer and it must persist as a standard only until something better has been proved feasible. Then it must yield its place to the improvement." [11]

It has been objected that standardization tends to excessive conformity and conservatism, that it would submerge all originality, variety, and style. Standards now dominate many interests too oppressively. Spontaneity is generally lacking in matters of taste and art. But is this indeed true? It often seems that the very opposite prevails. Is there not, in truth, less danger of predominant conformity and mediocrity than the objectors have supposed? In material things, in commonplace commodities, standardization and simplification may well reduce the bewildering diversity and discard many valueless distinctions; but in spiritual things the human spirit is not wont thus to submit and conform; individuality and originality will continue to sustain premium values. In the organization of experience, knowledge, and purpose there always inheres a development of the new from the old, a progress from the coherently organized and established to the plastically organic and the consistently *improved*. In economic and industrial matters scientific and technologic standardization has fuller justification, yet in the relevant bodies of organized knowledge, the scientific currents countervail stagnation. And in educational and social interests there should be ample place for personality, and individuality should be fostered, especially where talent is apparent, or may be latent. There should be sufficient freedom for divergent and progressive activities. Intellectual and æsthetic, and even moral and religious developments and

book compiled by the National Bureau of Standards. The *Yearbook* for 1928 had an equally interesting introduction on the "Scope of Standardization."

[11] *Annals, Amer. Acad. Polit. and Social Science*, v. 137, p. 42.

expressions should, so far as spiritual values may inhere and social welfare may allow, subsist in genial conditions of liberality and toleration.

"If an intolerable increase in the pyramiding of intangible values is to be prevented, it is evident that the consumer must decide when and where he or she desires low-priced, efficient, uniform, mass-produced goods of relatively invariable performance, and when high-priced intangibles and 'differences' — . . . .

"Types of consumable goods, whose use is in the main a matter of simple habit, are taken as matters of course and do not enter in any significant way as factors in the maintenance of one's social prestige, or in the satisfaction of aesthetic taste and appreciation. Such goods permit of standardization on a large scale: . . ." [12]

"There is nothing unsound in reducing the cost of production by standardization, nor in transferring to the worker in the form of increased wages part of the saving effected and later taking it back by selling him goods." . . . [But] "To standardize the individual in order to standardize the things it is intended that he should buy is to lose sight of the fact that goods were made for man and not man for goods." [13]

Standards are definable and applicable not only to quantities, but to qualities, and even to methods and choice of materials. Makers and users of commodities, manufacturers and purchasers, advertisers and even the ultimate consumers, may avail themselves of this organized and published knowledge, and herein their various interests are safeguarded at least in some measure. Falsification, adulteration, and misrepresentation may thus be measurably controlled, or checked, the more so, if it be feasible to maintain in integrity a system of inspection and reliable information. Consumers could thus purchase with more confidence and economy. Some of the wastes of advertising would be abated. One of the main purposes of advertising is to reduce competition. If so, competition of quality in the product should succeed to a competition of claims, which too often seems to stultify both the advertising interests and the common sense of the outwitted consumers.

[12] *Annals, loc. cit.*, p. 238.

[13] Siegfried, André, *America Comes of Age: a French analysis.* New York, 1927, p. 169.

The United States Bureau of Standards has derived and gathered an immense amount of information regarding products and commodities. This service, costing some $2,000,000. annually, has been maintained for economy in governmental expense, in which, it is estimated, many times this amount, probably $100,000,000., is yearly being saved. Much of this information has been published and is available to educational institutions and to business interests, which are increasingly making good use of it. It would be but a step of advance in the right direction to publish some of that scientific and industrial knowledge in such form as would be readily digested by the classes of consumers who are, or should be, educated well enough to understand it and to apply it in their economies and in their adjustments to the exigencies of modern life. Fostering business interests at the expense of the "public" should not be allowed to stand in the way of such liberal dissemination of valuable and useful knowledge.

"Business and industry must increasingly feel an obligation to discover the social implications in what they are doing. It is not enough to justify an institution merely by its effect upon business, for business, the supplying of the material needs of the world, must look for its own justification to its effects upon society. The place of standardization must therefore be judged from this broader, more thoroughly human point of view." [14]

3. AMELIORATIVE, ETHICAL, RELIGIOUS, AND PATRIOTIC ORGANIZATIONS.

Humanitarian and charitable, patriotic, ethical and religious organizations, associations, agencies, etc., are briefly mentioned. All these are organizations of purpose and of knowledge, and they tend to coöperate within the greater social organizations.

Among the countless ameliorative and patriotic organizations may be mentioned the National Federation of Women's Clubs, which may become no less influential than the great Federation of Labor. The National League of Women Vo-

[14] Albert W. Whitney, in *Annals, Loc. cit.*, p. 32.

ters may expand and coöperate with the National Federation to produce results of prime importance. By these and similar organizations such questions even as war and prohibition may be determined. The American Legion, composed of civilians who served in the World War, and, after it, returned to civilian occupations, has a moral and patriotic platform and is effectual in influencing opinion and legislation. One of the most remarkable patriotic developments is that of the Fascisti in Italy. This highly organized body has become a dominant power in the nation, and its leader as premier exercises the powers of a dictator.

The Roman Catholic Church is, and thru the centuries has been, one of the greatest and most efficient organizations that have ever existed. Its solidarity is remarkable. No government equals it in mastery of detail and in coöperation of constituents and members. The Federal Council of the Churches of Christ in America is composed of some thirty Protestant denominations purposing to coöperate in matters of common interest. The Protestant Episcopal Church in America in recent years has reorganized its work, more systematically and effectually dividing its fields and defining its activities. The Christian Science Church is almost as well organized as the Catholic, tho more freely. The Young Men's Christian Association, and the Young Women's, and the Boy Scouts have been well organized for their religious and educational purposes. The charity organizations, state and local, combining the services of many agencies, have, despite immense difficulties, accomplished much in relieving need, in ameliorating conditions, and in their consistent defense against imposture and wasteful dispensation. The great Red Cross service has become a most extensive organization for the succor of human suffering, especially in calamitous emergencies.[15]

[15] E. L. Fisk, *Health Building and Life Extension*, p. 478. The last part of Fisk's book has eight valuable chapters on the organization of public health interests, community, state, national, industrial, etc., also several interesting charts illustrating educative and welfare organizations of knowledge and purpose in these fields.

"There is need for the prevention of overlapping and duplication of work in such agencies. This need has been partly met by the organization of the National Health Council, comprising the following organizations:

American Public Health Association,
American Red Cross,
American Social Hygiene Association,
Conference of State and Provincial Health Authorities of North America,
Council on Health and Public Instruction of the American Medical Association,
National Child Health Council, with its affiliations,
American Child Hygiene Association,
Child Health Organization of America,
National Child Labor Committee;
National Committee for Mental Hygiene,
National Organization for Public Health Nursing,
National Tuberculosis Association,
United States Public Health Service (Conference member)."

The Rockefeller Foundation has very broad purposes and is administered liberally and judiciously. One of its most effective branches, The International Health Board, has cooperated with remarkable success in controlling yellow fever, malaria, hookworm disease, and tuberculosis. The Rockefeller Institute, a kindred organization, purposes "the investigation of such problems in medicine and hygiene as have a practical bearing on the prevention and cure of disease." Its valuable services are regarded as resulting largely from effectual organization.

These organizations function by organizing, that is, by accumulating, systematizing, rendering available, and propagating knowledge, thought, and purpose in their special fields. The knowledge may preëxist — in a less organized state, but usually it is organized as a result of the purpose, and confirms it. As educators, leaders, lawyers, statesmen, physicians, and philanthropists attain to more complete knowledge, individually and collectively, they organize to apply their organized knowledge and to effect their purposes.[16]

[16] That there is need of a book to describe "the forms of ecumenical cooperation" is declared by Graham Wallas in *The Great Society*, pp. 318–19.

Walter Lippmann stresses the importance of expert knowledge to business and to social organization: "Gradually, then, the more enlightened directing minds have called in experts who were trained or had trained themselves to make parts of this Great Society intelligible to those who manage it. These men are known by all kinds of names, as statisticians, accountants, auditors, industrial counsellors, engineers of many species, scientific managers, personnel administrators, research men, 'scientists', and sometimes just as plain private secretaries. They have brought with them each a jargon of his own, as well as filing cabinets, card catalogues, graphs, loose-leaf contraptions, and above all the perfectly sound ideal of an executive who sits before a flat-top desk, one sheet of typewritten paper before him, and decides on matters of policy presented in a form ready for his rejection or approval." [17]

Where organized interests come into contact or overlap they are coöperating or they tend to coöperate in the future. Thus there is developing a system of organizations, or an organization of society, which, tho it may continue to be imperfect, is gradually becoming more comprehensive and more complete.

4. INTELLECTUAL COÖPERATION AND EDUCATIONAL ASSOCIATIONS.

Many national associations of intellectual workers have been organized and these have combined or become affiliated in international unions, more or less closely related to educational associations and to the League of Nations' Commission and Institute of International Intellectual Coöperation, which have broader purposes. Educational interests, national, international, and professional, and library and bibliographical interests have been organized both structurally and functionally.

We have regarded the functional organization of knowledge as social and coöperative. The term *intellectual coöperation,* brought into eminence in the League of Nations' Committee of that name, which began to function in 1922, and in the Institute, established in 1926 to carry out the purposes of that Commission, denotes a broader and perhaps less distinct movement of many aspects and activities.

Its relation to the problems of intellectual life is of the broadest scope, including educational, bibliographic, professional, scholas-

[17] *Public Opinion,* p. 370.

tic, philosophic, scientific, literary, and artistic interests. The purposes and the forms of intellectual coöperation may be subsumed under the following captions:

(1) General and Educational: the advancement, communication, and dissemination of knowledge and thought, understanding and intelligence, learning and purpose, culture and taste. Scientific and educational associations and institutions serve these purposes, also governmental departments, commissions, bureaux, etc., and special commissions, conferences, agencies, etc., national, international, state, and municipal.

(2) Organization, synthesis, correlation, subordination, coördination, and systemization of knowledge, thought, and purpose. It is maintained that these processes would promote the purposes mentioned under the preceding caption, and also those of the following. The strictures against specialization and the subordination of the special to the general are implied in the principle of synthesis and organization. The objections to specialization are largely removed by subordination, correlation, and synthesis. This is one of the main theses of the present book.

(3) Selection, criticism, abstracting, simplification, clarification, and humanizing of intellectual productions: ideas, ideals, theories, doctrines, beliefs, morals, methods, standards, techniques, and arts. Without coöperative and organized selection, made judicious by sane criticism grounded in valid knowledge, the human intellect would be overwhelmed by its own product, even where specialized. Coöperative abstracting is a means to selection. Simplification, clarification, and humanizing are coöperative in purpose rather than in method. They are of high educational value and are especially needed after a period of specialization and sophistication, such as that from which the intellectual life is now, let us hope, emerging.

(4) Bibliographic and bibliothecal services, including information bureaux. The publication of books, pamphlets, journals, reports, etc. would be subsumed here, and also under the first caption. In these fields there are many forms of intellectual coöperation ranging from interlibrary lending to coöperative cataloging, and from active collaborative writing to the passive coöperation of permitting quotation and excerpt.

(5) Social, or community, coöperation: societies, associations, unions, circles, fraternities, fellowships, etc. foster intellectual cooperation in many relations.

(6) Financial status of intellectual workers and pecuniary assistance to needy members are matters in which the associations and fraternities serve some of their most worthy and valuable purposes.

These views and statements are partly drawn from two excellent little books: *Principes de la Coöperation Intellectuelle internationale,* by Julien Luchaire, (Paris, 1926, 100 pp.), published for the Carnegie Endowment for International Peace; and *Learning and Leadership,* a study of the needs and possibilities of international intellectual coöperation, by Alfred Zimmern, (Oxford University Press, 1928). The latter summarizes the problems of intellectual life under five headings that may be briefly indicated as follows: (I) Organized coöperation in the promotion of the world's intellectual life; (II) Specialization; (III) Financial, or pecuniary, conditions of intellectual workers: (IV) Intellectual freedom; (V) Commercialization in art and literature, and its effects on scholarship, research, and publication. It is the first of these that broadly is one of the main interests of the present book. The second is one of the tendencies that the comprehensive synthesis we outline and advocate would countervail. The third we consider briefly in the immediately following pages. The fourth and fifth we touch upon only by implication.

M. Luchaire outlines the purposes of the Institute, (whose Director he is), and its work in the near future, under the eleven following items: (1) Right of property in scientific productions; (2) International organization of bibliography; (3) Exchange of information and publications regarding the movement; (4) Facilitation of the exchange and lending of books from libraries, etc.; (5) Selection and editing of literature, especially scientific literature. (6) Exchange of professors and of students; (7) Education in international interests; (8) Protection of archeological remains; (9) Coöperation in library services; (10) Agreements regarding museums and expositions; (11) Improvement of cinema productions. (These items are adapted in translation).

The professional organization of intellectual workers has been progressing rapidly thruout Europe, but especially in France and England. There are hundreds of associations purposing to promote or defend the respective professional interests.

About two fifths of these are national and three fifths are not national in their organization nor affiliated to national or international organizations. Some of these professional groups are organized as mutual benefit societies, while others are like trade, or labor, unions, and some are even affiliated with labor federations. These associations are uniting in national and international organization. In France there is a Federation of Intellectual Workers, linking nearly a hundred professional associations. There is also a nation-wide association of Compagnons de l'Intelligence, which

workers of whatever class or profession may as individuals join. The Federation is a representative body, each member-society being represented by from one to ten delegates.[18]

The announced purpose is organized action protective of the rights and interests of intellectual workers. The internal affairs of the member-societies are not to be interfered with. The British, the French, the Austrian, and probably the German national federations, or associations comprise each some hundreds of thousands of intellectual workers; and the aggregate of the affiliated memberships probably numbers over a million, and those not yet affiliated probably another million. Completer organization might add a third million. These organizations national and international are, or should be, affiliated with scientific and educational organizations, national and international; and they should be brought together under the auspices of The League of Nations and under The Union of International Associations, instituted at Brussels in 1910. Here would be an immense power to stabilize social organization throughout the civilized world and to maintain and advance civilization and culture, now endangered by adverse economic conditions and by psychopathologic degeneration.

The first International Congress of Intellectual Work was held at Brussels in 1921. Here the French confederation advocated completer national and international organization, and The League of Nations was called upon to give recognition to this as to other international interests. As a result the League in 1922 instituted its Committee on Intellectual Coöperation. This organization of purpose first undertook an organization of relevant knowledge, "a general inquiry into the present conditions of intellectual life, including the economic conditions of intellectual workers, with particular reference at first to artists, musicians, and university professors; assistance to nations whose intellectual life is endangered, especially Austria and the nations of Eastern Europe; the international organization of scientific bibliography, . . . international coöperation between universities, and the protection of literary property. . . . The organization of intellectual workers has passed from the plane of theory or speculation to that of fact, and the movement has taken the world for its parish." [19]

The League's Committee on Intellectual Coöperation has at present fourteen members (besides the Chairman), representative of several nations. The United States, tho not in this membership, is represented on the Board of Directors. Sub-committees for special purposes are composed of a few members and a few

[18] These and the following statements are abstracted from William MacDonald's book, *The Intellectual Worker and His Work,* Macmillan, 1923, Chapters 12 and 13.

[19] MacDonald, *Op. cit.,* pp. 304–5.

specialists chosen from the respective fields of interest. National committees for some thirty-five nations are comprised in this organization. There is close affiliation with the chief national and international associations. The Committee meets once or twice a year and indicates policies and projects.

The International Institute of Intellectual Coöperation, established to carry out these undertakings, some of which are specified a few paragraphs above, has seven sections dealing with: University relations, Scientific relations, Legal service, Literary relations, Artistic relations, Information and reference, Administrative services. The section on scientific relations purposes to undertake, as soon as it is feasible, a bibliography of science more or less comprehensive. The information section will consider questions concerning books and libraries, with a view to coöperative services. The French government has pledged liberal support to this Institute.

The League's Committee on Intellectual Coöperation has also established the International University Information Office, which purposes to promote coöperation of national institutions for purposes of communication, information, publicity, and exchange of professors.

The Institute of International Education, a precursor in this field, organized in the United States, is, in conjunction with the American University Union and the American Council for Education, extending to many other nations its liberal services in the interests of higher education, and also coöperating with other educational organizations.

The American Association of University Professors is not merely protective but purposes "to facilitate a more effective coöperation among teachers and investigators in universities and colleges . . . for the promotion of the interests of higher education and research, and in general to increase the usefulness and advance the standards and ideals of the profession."

The organization of educational interests for the advancement and dissemination of better education was advocated by Dean William F. Russell, in referring to the "Denver plan", in the following terms: ". . . the combination of all our educational forces to the end that in a scientific manner there may be assembled, analyzed and synthesized the best

that has been thought, said and done in connection with that which children are taught." [20]

The World Federation of Education Associations, organized in 1923, purposes to disseminate "information concerning the progress of education", to coöperate with the League of Nations and other related organizations to develop international comity thru education, "to find those elements of education which are universal and apply them to the good of all nations", and especially to promote the study of international relations and interests. Among "special objectives" [21] are "justice and good-will", tolerance, appreciation of heritage, international morality, and unity and peace. In accordance with these objectives several committees are purposed to coöperate with established organizations to promote education for peace, to "investigate the teaching of history" with regard to "international amity", to promote international understanding among "students of various ages", to investigate the "arguments for war" and the "incentives to war". Of special relevance to the interests of this book are three special committees, one on the developments of universities and the feasibility of a world university, another on the Fields of Knowledge, to "inquire into the interrelations and increasing unifications of the various fields of knowledge and research toward a fuller and clearer coördination of subjects of instruction", and a third, on Bibliography, to consider "the establishment of a universal library office and inquire into methods of bibliography and their possible advances". The Federation's membership is of associations or organizations in any part of the world. Universities and school boards may become "associate members". The representation is by delegates, one "for each organization entitled to full membership, and one additional delegate for each two thousand members of the organization or major fraction thereof, with a maximum of fifty delegates

[20] *School and Society*, for Aug. 15, 1925, p. 189.
[21] These quotations are from a publicity pamphlet of the Federation.

for any one organization". The National Education Association in the United States now has that number.

The National Education Association, with about a hundred-and-fifty thousand members, is hardly less important in its relations and influences than the United States Department of Education. Its functions are apportioned to some twenty divisions, such as those for Secondary Education, Vocational Education, Physical Education, and Libraries. More or less closely articulated with these national organizations are the state and the city education departments, the great foundations from private capital, and the protective associations of teachers and others. The American Federation of Teachers is affiliated to the American Federation of Labor.

The American Library Association is the inspirational and educational summit of a system of service and far-reaching development that are of high efficiency and high social value. "Thru national, state, county, municipal and endowed public libraries, continuous education may be provided for all ages and classes of people at a very small expense as compared with that of their formal education. No less important in the economy of daily life is the recreational service of libraries." [22] The Association has (1928) a membership of over 11,000; it has nine sections and some sixty committees (more than half of which are standing committees) engaged in studying real problems. Six of its Boards and standing committees are of very broad educational purpose: the Board of Education for Librarianship, the Board on the Library and Adult Education, and the Committees on Bibliography, on International Relations, on Study of Development of Reading Habits, and on Education, the last having five sub-committees. It has also a Board of Publications and an Editorial Committee, both largely serving the educational purposes of the Association. "Its publications are now of

[22] From "An Address to the American People", published by a committee of the A. L. A. in January, 1926.

more general interest and value than ever before. It has published (in four volumes) the results of a general survey of libraries, which is intended to show how libraries do their work." It conducts the Paris Library School, an international school for librarians, to which increasing numbers are coming, of many nationalities. Its services and influences are extending in many and new directions; they are world wide, and they are of immense importance.

The organization of agencies for adult education has been one of the dominant interests and activities of the American Library Association during the past four or five years. The A. L. A. Board on the Library and Adult Education adopted in 1927 a plan of work in four divisions:

"1. A service of information and advice to libraries desiring assistance in the extension of their educational work with men and women.

2. Coöperation with national institutions, associations, and organizations which have in common with public libraries some educational interests.

3. Conducting or assisting in conducting investigations and studies which promise to be of practical use to libraries and which come within the charter of the Board.

4. A service which informs the public of the possibility of self-education through good reading, and of the usefulness of public libraries in this field."

This Board is articulated with the American Association for Adult Education, and is affiliated with the National University Extension Association and with the American Alumni Council, and with other institutions for extending educational influences and services. The A. L. A. Committee on the Study of the Development of Reading Habits has undertaken jointly with the A. A. A. E. an investigation of large importance. The A. L. A. series of booklets well known as *Reading with a Purpose Series,* in which so far about forty courses have been published, has had a sale aggregating nearly half a million copies.

The American Association for Adult Education, founded in 1926, has thru the activity of the many educators who comprise its Council and Executive Board and thru wide cooperation with some four hundred organizations attained to a place of leadership in educational purpose in America. The Association's principal aims are to gather and dissemi-

DREW UNIVERSITY LIBRARY

nate information concerning adult education; to offer its services to groups and to advise those desiring to initiate educational work or to study by themselves; to publish material useful to those in the field; to assist in studies of problems fundamental to adult education; and to arrange conferences where ideas may be exchanged and the varied experiences of adult educators brought together. A large amount of pamphlet material, including bibliographies, reading-lists, reading-courses, syllabi, reports, etc., has been sifted, classified, and cataloged in the office of the Association. Community organization for adult education has developed rapidly, especially in Cleveland, Buffalo, Dallas, Detroit, Brooklyn, Chicago, and St. Louis. The Association distributes to its members and its Council printed material dealing with the various aspects of adult education; and it publishes a quarterly periodical. Its Research Committee conducts or has under consideration studies and experiments in adult education in museums, in art, in music, in drama, in motion-pictures, in radio-communication, and in cultural programs in industrial organizations. The purpose of the Association has been to explain and to clarify adult education, but not to move more rapidly than does the nation itself in the development of adult education.[23] Similar movements have been organized in Europe under the auspices of the World Federation for Adult Education, which holds international conferences.

Organization of international relations was made the purpose of a committee of the International Congress of Librarians and Booklovers at Prague in 1926. The League of Nations Committee on Intellectual Coöperation has made a similar recommendation. Its sub-committee on Bibliography, said Dr. Hugo Krüss, one of its members, in his semicentenary address at Atlantic City, has before it the question "how it may be rendered easier, by international coöperation,

[23] The above statements are drawn from the American Library Association's *Adult Education and the Library*, v. 3, No. 4 (Oct. 1928).

to obtain information as to what books are contained in the various libraries concerning a given subject. . . . There is reasonable hope that this move may lead to coöperation of great value to all scientific work thruout the world, and that, moreover, such coöperation may establish mutual relations between the libraries that will prove of benefit to other common tasks as well." More concretely the proposal is to maintain an international information service at all national libraries.

The International Institute of Bibliography has coöperatively for two decades been elaborating its immense catalog of recent contributions to the whole range of knowledge and thought.

An organization of art interests in New York was projected recently to include the cultural and also the financial interests of music, graphic and plastic arts, architecture and certain minor arts. In the literary and dramatic arts five associations may be mentioned together in this context: The Authors' League of America, The American Dramatists, The Actors' Equity Association, The Producing Managers' Association, and The Drama League.

The motion-picture play, which has developed so rapidly and so marvelously, has become a great force in American life, but it would also have become a great menace, if left unregulated in the hands of commercial interests. The objections and warnings uttered by sociologists, moralists, and ministers of churches touched the national conscience, and the reaction was felt by the organized interests that were making immense profits from the business. These organizations combined under the corporate name of the Motion Picture Producers and Distributors of America and called a conference in 1922 at which there met "more than one hundred representatives of national civic, religious, educational, and welfare organizations of the United States together with the representatives of exhibitors', actors', and authors' organizations. The purposes and functions of this organization are

in epitome: inter-communication between the motion-picture interests and the agencies for forming and interpreting public opinion; the increasing use of motion-pictures to inculcate citizenship and sociality; coöperation between the motion-picture producers and the public, and especially with the National Education Association and the Drama Council of the Federal Council of Churches, for the educative use of motion-pictures in the schools; by proper representation of American and foreign life the furtherance of Americanization and of international amity; and the maintenance of the "highest possible standards of art, entertainment, education and morals in motion pictures."

These declarations express interests and purposes that are probably sincere, and, tho the results may as yet be unsatisfactory, there has indeed been marked improvement in the moral tone and social effect of the motion-pictures. The results evince the benefits of coöperative organization.

5. FUNCTIONAL ORGANIZATIONS DEPEND ON STRUCTURAL ORGANIZATIONS OF KNOWLEDGE.

The organization of purpose depends functionally on the organization of knowledge; and functional organization depends on structural. Aggressive organization is distinguished from defensive. Organization of knowledge for the people should be provided first by educational institutions, then by journals of news and opinion, and generally by libraries, and specially by information bureaus. Thought, philosophy, and the literature of information should be well grounded in organized knowledge. All these provisions should make for law and order, advancing the rule of reason and mental control.

The organization of rational purposes depends functionally on the organization of relevant knowledge. How predominant the purpose to organize knowledge now is not only in the institutions of science and technology but also in industrial organizations and those of government is evident in their published reports and proceedings. But all this organization should be more adequately functional and effectual.

In such organizations the structural relations of the departments or offices are based on knowledge of the fields

covered and of the purposed functions; and, conversely, the functions or services of the several departments depend on a proper partition of the knowledge developed in the study, service, or business. Each office has specified relations, functions, or duties, collecting and utilizing knowledge applicable to its specialty, and thus it serves the interests of the whole organization. These relations are centered about the chief executive, in whom the knowledge is unified and who directs the duties and regulates the functions. Knowledge is needed all along, and is being organized all along. In the prospective stage it is presumptive, or speculative; in the organized stage it is assured or professional or scientific. If the business or service can begin with knowledge well organized previously in the field, then so much the better. And it is not only knowledge that is thus organized, but thought and purpose.

Against aggressive organized interests are sometimes opposed defensive organizations, among which may be mentioned the trades unions and the consumers' leagues. To a considerable extent the labor organizations are now regarded as having passed from the defensive to the aggressive; but it would be fairer to say that they exist both for defense and for aggression.[24]

In the mêlée of conflicting interests in which the bewildered denizen of the world now strives to recover his mental equilibrium he is on all sides pounded by appeals, arrogant or pathetic, and he must defend not only against aggressive organizations, whether of politicians or profiteers, but also against the propaganda of organized movements, some futile, some unworthy, some even vicious, that flare thru the glittering streets of the metropolis of advertisement. To ward off such importunities a body of opinion proceeding from well organized common knowledge and social education would usually prove effectual; and this is what the people need to

[24] Cooley's *Social Organization,* Chapter XXV, is recommended here as concise, fair, judicious, and clarifying.

protect their pockets from profiteers and their democracy from politicians.

Professor Knight Dunlap in his *Social Psychology* gives a concise and illuminating account of the Principles and Rules of Propaganda. "These rules", he says, "read like a catalog of social shame, but that they are in use is a 'condition and not a theory', and it is imperative that those to whom propaganda is directed should recognize them, since the propagandists recognize them well enough".[25]

Education for social adjustment is one of the principles of current educational philosophy, and this implies information regarding social and economic conditions. The journals of news and opinion should with less partizan interest than at present continue the dissemination of information. The movement of adult education, in which schools, colleges, universities, and libraries are evidently purposing to coöperate, should extend the scope of this information and education and should carry it to higher levels of intelligence and social value.[26]

How "intelligence bureaus" in governments might coöperate with research organization in universities and other institutions is indicated by Walter Lippmann in a chapter of his *Public Opinion* (see especially pp. 292-3). Professor W. J. Shepard, writing on Bureaus of Political Research, names three kinds: (1) Voluntary organizations maintained by private endowment, (2) Organizations established by governments, (3) Bureaus connected with state universities. "Altogether these institutions", he says, "constitute one of the most important and interesting developments in the field of political science at the present time." [27]

For better service the professions need more adequately organized knowledge. Even in the fine arts and the literatures it were well to cultivate criticism based on knowledge of

[25] Chapter VIII, p. 256.

[26] Optimism regarding democracy is at present "under a cloud", says John Dewey in a penetrative chapter on "The Eclipse of the Public" in his recent book, *The Public and its Problems;* and in the succeeding chapters he shows how the Great Community will find itself thru education developing experience.

[27] In *The History and Prospects of the Social Sciences,* edited by H. E. Barnes, p. 427.

nature and human nature. The jazz music, the poorer-than-jazz poetry, the degenerate drama, and the bizarre contortions that afflict our senses in the art exhibitions should be made to justify humanistically their pretensions to be expressions of nature or of human nature. They flout intelligent, perduring criteria; they are transient and unstable. Æsthetically they never attain to the beauty and truth that has inspired the great traditions they crassly repudiate.

While a moderately free rein should be given to the authors of art and literature who aim to entertain, those who profess to give information or insight should be appraised by sane and valid criticism grounded in well organized knowledge and well reasoned philosophy.

Ultimately it is a matter of order and system. This does not mean, however, that the order is immutable and the system should be inflexible. There should ever be provision for new orders to meet new needs and changing conditions, — new orders resulting from new relations. Organization implies order and system; and social organization implies also social purpose and coöperation.

What may well be emphasized here is that all such social and industrial, intellectual and purposive organizations depend on organizations of knowledge, on compilations and classifications of relevant knowledge. Structural organizations and classifications serve functional organizations and systems. Thus syllabi are structural scaffoldings to educational studies or to functional organizations of knowledge. As in biology, structure and function are correlative. Functional organizations would therefore be served well by the construction of more consistent and efficient classifications of knowledge — consistent with the mental process by psychologists and educators termed "organization of knowledge", consistent also with what we term — bearing in mind its relativity — the scientific and educational consensus.

The social components of common knowledge, the communities of minds in schools, associations, and nations, the

coöperative tendencies of modern society, the interrelations of business, of arts, of sciences, of societies, have produced a mental, social, and economic tissue that needs but more consistent structure and more coherent functional organization to become not merely a community but a social organization indeed, ruled by reason proceeding from knowledge rather than, as now it seems, by unreason and comparative ignorance in ineffectual governance of imperfect and unruly human nature.

CHAPTER III

THE ORGANIZATION OF SCIENCE.

1. NATIONAL AND INTERNATIONAL ORGANIZATION.

Urgent pleas of eminent men have led to rapid progress in the organization of scientific research, nationally and internationally, as well as by sciences and technologies. The International Association of Academies, The American Association for the Advancement of Science, The National Research Council, and The International Research Council are especially mentioned.

The need for completer organization in scientific research was the topic of an address to the National Academy of Sciences in 1913 by the eminent British scientist, Sir Arthur Schuster. The following extract does scant justice to the theme. But that was before the war. "Ours is an age of organization presenting many problems that cannot be confined within political boundaries. The demands of science have already called into existence separate international associations, which are efficiently performing their duties. Nevertheless the continued increase of their numbers is beginning to cause inconvenience and is likely to hamper future developments unless they can be united by some bond intended to coördinate their work. The International Association of Academies stands out as a central body, fit to act as a central advisory authority."

Two years later Lord Holland in an address particularized some of the inconveniences and wastes that should be abated by better organization of research. "Our scientific and technical societies similarly suffer from overlapping and conflicting interests", he said, and he urged coöperation, partition of field, classification of interests and studies, and centralization of the most important publications for economy both of the coöperating societies and of the individual scientists engaged in research.

The union, coördination, and coöperation of academies or other scientific institutions may serve several important purposes, among which the following may be outlined: (1) Provisional partition of the fields of research to provide against needless duplication or repetition of individual or cooperative undertakings. (2) The defining of problems and estimating the feasibility of research. (3) Coöperation in actual search for material, or in sorting and interpreting the data. (4) Evaluation of materials, and criticism of conclusions. (5) Exchange of materials, and translation of contributions. (6) Assisting, or encouraging, needy corporate members, as these in similar ways may, or should, serve their individual members. (7) Coöperation in bibliographic undertakings. (8) Coöperation in, or contribution to, publications. (9) Advocating and representing comprehensive scientific and international views and policies for members individual and corporate.

Most of these services are appropriate to scientific organizations, whether of national, or local, or special field. These interests have by extension from bodies of smaller scope given rise to the more comprehensive associations.

The tremendous efficiency of Germany during the world war depended largely on thoro national organization of knowledge. In France, in England, and in the United States, the war necessitated similar, if less complete, organization for the needs of the nation. A survey of national scientific and industrial organizations was proposed and partly accomplished.

"The nation requires organized knowledge for administration, for safeguarding the public welfare and for directing the best development, utilization and conservation of national resources, natural, intellectual, manual, and financial. Organizations require it for the attainment of their purposes. . . . Although the advantages of its application are matters of the simplest common sense, we are but beginning to apply organized knowledge in an organized manner. The results to be anticipated from such a general and systematic application are almost beyond conception." [1]

[1] Prof. P. G. Nutting in *Scientific Monthly*, May, 1918.

But in the last ten years the progress of organization in science and technology in the United States has been rapid and extensive. The National Research Council was organized in 1916 under the National Academy of Sciences.

"In 1918, by executive order of the President of the United States, it was reorganized as a permanent body for the promotion of research in the Natural Sciences and of the application and dissemination of scientific knowledge for the national well-being. Departments of the Government are directed to coöperate with the Council; but although closely and cordially related to the Government, the Council is not a governmental bureau.

"The Research Council has seven divisions of science and technology, dealing with 1. physics, mathematics and astronomy; 2. engineering; 3. chemistry and chemical technology; 4. geology and geography; 5. medical sciences; 6. biology and agriculture; 7. psychology and anthropology; and six divisions of general relations, namely, 1. Federal relations; 2. foreign relations; 3. states relations; 4. educational relations; 5. research extension, and 6. research information.[2]

"The purpose of the Division of Engineering . . . is to encourage, initiate, organize and coördinate fundamental and engineering research and to serve as a clearing-house for research information in the field of engineering."

The division is limited to forty members, twenty-one chosen from eleven leading affiliated societies of Engineers, seventeen members at large, besides the Chairman, *ex officio,* and a member from the Division of Federal Relations. Advisory boards, or committees, have been organized in the several fields of engineering and "sponsored" each by the affiliated society representing that field. Research and Special Committees are appointed at the discretion of the Executive Committee, and Joint Committees are provided for.

"The Division of Anthropology and Psychology . . . aims to be of service chiefly in three directions: first, assistance in the coordination of research activities already in progress or in contemplation, to encourage team work, minimize duplication of effort, and decrease the magnitude to the gaps in the front line of attack on the most vital problems of scientific investigations; second, assistance to the representatives of industries, museums, government departments and other agencies, in the definition of their research problems; and, third, assistance in bringing these agencies into touch with the scientists who are in a position to aid in the solution of their problems." [3]

[2] From a publicity pamphlet issued by the Council.
[3] W. V. Bingham in *Science,* N.S., v. 41, p. 353–4.

The American Association for the Advancement of Science is associated with the national societies devoted to the several sciences. It may be regarded as an association of these societies; they are represented by delegates on its council and have charge of the scientific programs when they meet with it. The fifteen sections of the association cover the pure and the applied sciences, including the psychological, humanistic, and political sciences. Committees of these sections and the council of the association are representative of the association and of the affiliated societies.[4]

"The American Association has accomplished important work through its council, through its executive committee, through its sectional committees and through numerous special committees, including the committee of one hundred on public health and the committee of one hundred on scientific research. The latter committee, organized in 1914, arranged subcommittees on research in each of the sciences, on grants for scientific research, on research in educational institutions, on research under the government, on research under states and municipalities, on research in industrial establishments and in other directions."

The Association has over sixteen thousand members. At the New York meeting, in 1928, the attendance was officially estimated as over 4,800; forty-five organizations were related to the Association or to its sections; about 250 sessions were held, and about 2,200 papers were presented.

The several administrative departments of the United States government have for half a century been organizing scientific investigation of problems of public importance and applying the knowledge so organized or disseminating it for others to apply. A single instance of these well-known services must suffice here, that of the Bureau of Entomology, of whose work the following interesting statements were made by Dr. L. O. Howard, as Chief:

"At the present time more than 140 distinct projects are being investigated by the federal bureau, and these projects involve possibly five hundred of the species of insects most injurious to crops,

[4] The *fifteen* sections are named in order on page 394. The quotation here is from an article on "The Organization of Scientific Men" in *The Scientific Monthly*, June, 1922, by its editor, Dr. J. McKeen Cattell.

domestic animals, stored foods, forest products, shade trees, and ornamental plants. It is safe to say that some form of remedial treatment has been found for almost every markedly injurious insect in the United States; but continued efforts are being made to find something more effective, or cheaper, or simpler."

"Country after country has organized its entomological service, following the lead of the United States, which was the first country to begin to study insects in a really competent way from the economic point of view. . . . France and Italy particularly have shown themselves to be keenly alive to the importance of this work. . . . Great Britain is developing many competent workers in her vast colonial possessions. . . . In London there is an imperial Bureau of Entomology, which is in constant touch with the official entomologists of the different dominions and colonies and assists them in many important ways." [5]

Research and publication of the results are services maintained not only under the government of the United States in coöperation with scientific societies, universities, and private research laboratories, but in other countries also there is similar organization of extensive coöperative research and of applicable knowledge. The system and efficiency of Germany in these matters have long been recognized as of very high value in the national economy and as of large importance to scientific research in other nations, to which the results are directly or indirectly available.

Research has been endowed and organized in many institutions, of which we will instance here only a few most important in the United States: The Smithsonian Institution, and The Carnegie Institution, of Washington; The Franklin Institute of Pennsylvania, and The Wistar Institute of Anatomy and Biology, of Philadelphia, The Rockefeller Institute for Medical Research, The Scripps Institute of Oceanography, The American Law Institute, The National Research Endowment, The Rockefeller Foundation, and The Commonwealth Fund.

Scientific research is already organized as regards its institutions, tho less completely than is desired. All the chief nations have national organizations, affiliated with which are many state and local academies and societies; and among

[5] In his chapter, "Our Fight against Insects", in the book *Science Remaking the World,* edited by O. W. Caldwell and E. E. Slosson, pp. 196–7 and 191–3.

these there is considerable coöperation. Each science moreover has its national and its international organization, and so has each important technology. There are international Unions for the several sciences, with sections for special fields of research; and there is an International Research Council. Unifying all, at least in certain relations, is the Union of International Associations.

The purposes of the Council are stated as follows: "(a) To coordinate international efforts in the different branches of science and its applications. (b) To initiate the formation of international associations or unions deemed to be useful to the purposes of science. (c) To direct international scientific action in subjects which do not fall within the province of any existing association. (d) To enter, through the proper channels, into relations with the governments of the countries adhering to the Council to recommend the study of questions falling within the competence of the Council." [6]

2. FUNCTIONAL AND COÖPERATIVE ORGANIZATION.

The importance of more effectual coöperative organization in research, in application of scientific knowledge, in bibliographic and in other services, is urged by leading scientists, tho strictures are admitted regarding the control of individual interest and initiative, which should remain comparatively free.

This great system should become more effectual both structurally and functionally as a system not only of relations, exchanges, communications, and standardization, but also of coöperation in services and activities. More definite measures have been proposed.

The organization of knowledge from this point of view was the chief topic of an address by Dr. Frederick L. Hoffman as Chairman of Section K of the American Association for the Advancement of Science at the meeting in December, 1921, which was printed in *Science* for March 10th and 17th following.

Professor Burton E. Livingston, as Chairman of Section G, Botany of the Association at the meeting in December, 1918, in an excellent address on "Some Responsibilities of Botanical Science"

[6] *Nature*, v. 103, p. 465.

stated these desiderata (among others): that special subjects in study and in teaching should be viewed in their relations to other subjects or sciences and to the system of the sciences; that the organized knowledge should be selected, abstracted, digested, appraised, and handed down to posterity; that there should be *"a national or international institute for the furnishing of bibliographical information on request;* that scientific research should be, as science teaching is, recognized professionally; that it should be organized coöperatively; that it should be planned, that the data should be procured, that the results should be presented and interpreted, published, and criticised — all coöperatively; and that the problems should be listed by a recognized organization, and new projects proposed.

This abstract does scant justice to Dr. Livingston's suggestive paragraphs, and it seems well worth while to quote some sentences of especial interest and relevance to our arguments: "In the first place, ever since my student days it has seemed very strange to me that the devotees of science lay so little stress on the broader and more general aspects of their work and upon the aims that are held in view. . . . We imply that this general orientation, this appreciation of the relations between our particular small chapter of science and the great body of human knowledge, will care for itself, without conscious attention. . . . It often seems that each worker brings forward his contributions without any notion as to how they are to fit into the structure of the science as a whole. It is somewhat as though each of us brought what he happened to have and threw it on a large and heterogeneous pile, hoping that a rational structure might by some unknown means, be builded therefrom." [7]

"Coöperation in Research" was the title of an important address by Dr. George Ellery Hale, then Director of the National Research Council, before the Royal Canadian Institute, in April, 1919. Dr. Hale there quoted two paragraphs of the Hon. Elihu Root, eminent lawyer and statesman, but who was also for many years the president of the board of trustees of the Carnegie Institution and an active member of its executive committee. "Thus kept in close touch with scientific research," Dr. Hale said, "he is well aware of the vital importance of individual initiative and the necessity of encouraging the independent efforts of the original thinker."

The following sentences of Mr. Root's are here abstracted:

"Science has been arranging, classifying, methodizing, simplifying everything except itself. . . . It has organized itself very imperfectly. Scientific men are only recently realizing . . . that the effective power of a great number of scientific men may be in-

[7] *Science,* N.S., v. 49, pp. 201 and 204.

creased by organization. . . . Your isolated and concentrated scientist must know what has gone before, or he will waste his life in doing what has already been done, or in repeating past failures. He must know something about what his contemporaries are trying to do, or he will waste his life in duplicating effort. The history of science is so vast and contemporary effort is so active that if he undertakes to acquire this knowledge by himself alone his life is largely wasted in doing that; his initiative and creative power are gone before he is ready to use them."

From Dr. Hale's concluding paragraphs the following opinions are quoted: "Most of the larger problems of physics and chemistry, though open to study in any laboratory, could be attacked to advantage by coöperating groups. In fact, it may be doubted whether research in any field of science or its applications would not benefit greatly by some form of coöperative attack.

"As for the fear of central control, and of interference with personal liberty and individual initiative, which has been entertained by some men of science, it certainly is not warranted by the facts." [8]

Some limitations and objections to organization or coöperation in scientific research were indicated by Dr. Francis B. Sumner, who, while recognizing the values in some fields, denied them in others, and emphasized the advantage or even the necessity of independence in some kinds of scientific work. Intellectually, said Dr. Sumner, the scientist should be free; his interest and incentive should not be directed; nor should the coöperators try to shape his materials.[9] Dr. Sumner should, however, bear in mind that all science is coöperative or social — tho in varying degrees. Individually the scientist may accept, and voluntarily he may contribute to, the organization of knowledge, of thought, and of purpose; but in doing so he is social; he neither makes, nor can he maintain, any contribution to science independently of other scientists — nor of the organization of science.

Professor William M. Wheeler, as retiring Chairman of Section F, Zoölogical Sciences, of the Association, delivered a most interesting address on "The Organization of Research", at the meeting in December, 1920, making special reference to Dr. Sumner's article and drawing similar strictures regarding the regulation of the intellectual and originative interests and undertakings.[10]

Another aspect of this important subject, "The Organization of Scientific Men", was treated by Dr. J. M. Cattell,[11] who argued very forcibly for ampler recognition of the services of scientists,

[8] Dr. Hale's address was reprinted in *Science*, N.S., v. 51, p. 150.
[9] *Scientific Monthly*, v. 8 (1919), p. 258 ff.
[10] *Science*, N.S., v. 53, p. 53 ff.
[11] *The Scientific Monthly*, June, 1922.

for professional status, more adequate compensation, and a larger share of the property rights in their productions.

Still another important aspect has recently become manifest in the National Research Endowment under the auspices of the National Academy of Sciences. The Trustees of the Endowment have issued a call for funds to endow research in pure science, declaring (after other statements): "(4) That scientists exceptionally qualified to widen fundamental knowledge through research are of such value to the nation that every effort should be made to facilitate their work. (5) That the overcrowding of educational institutions, and the consequent excessive demands of teaching and administration, have further reduced the limited opportunities for research previously enjoyed by the members of their faculties."

Making due allowances for the strictures drawn in the articles cited and for the limitations and the futilities of intellectual coöperation in research, we must conclude that the argument for organization is predominantly in the affirmative. The utilization of scientific knowledge in man's effort to control nature for his needs and purposes, that is, to acquire more extensive and more effectual control of certain natural forces and resources, was the main theme of a very earnest address by Sir Edwin Ray Lankester at Oxford University in 1907. After a convincing presentation of the need, he made a strong plea for fuller recognition, in the University and in the Government of the nation, of the paramount importance of scientific studies and of research in scientific fields. From the conclusion we quote these emphatic sentences:

"Even the slight and rapid review just given of Man's position, face to face with Nature, enables us to see what a tremendous step he has taken, what desperate conditions he has created by the wonderful exercise of his will; how much he has done and can do to control the order of Nature, and how urgent it is, beyond all that words can say, for him to apply his whole strength and capacity to gaining further control, so that he may accomplish his destiny and escape from misery." [12]

The philosopher, John Dewey, has echoed this call in his *Reconstruction in Philosophy,* expressing high appreciation

[12] *The Kingdom of Man,* p. 47.

of the human value of scientific knowledge. "The great need is the organization of coöperative research, whereby men attack nature collectively and the work of inquiry is carried on continuously from generation to generation."

3. SYNTHESIS AND THE SYSTEM OF THE SCIENCES.

Synthesis in science is defined. Sciences and studies are interrelated with regard to their contents, interests, and interdependence; and these are correlative to the intricate realities of nature and life. From the intrinsic and coherent relations of these derives the *order of nature*. On these correlations and on this order is based the system of the sciences, which implies a unity. Comprehending this, scientists are coming to develop their special and analytical studies more synthetically and comprehensively. From such comprehension arises scientific intelligence.

But the highest and broadest aspect of the organization of science we have not yet considered, nor are we prepared to do so adequately, until after we have studied the fundamental realities and relations on which it is based. That study will occupy several of the subsequent chapters of this volume, which is largely devoted to this very subject in its entirety — the organization of science.

The structural organization of scientific bodies and studies, which has been outlined in the first section of this chapter, and the functional organization of scientific research and related services, which has been briefly dealt with in the second section, are the outcomes, not the origins, of the pervading, intrinsic organization of science which we have in mind. This organization of science develops from the intrinsic and coherent relations of the intricate realities of nature and of life, from which also derives the *order of nature*. Correlative to these realities and relations, the distinct sciences and studies have developed, and they are likewise interrelated with regard to their contents, their interests, and their interdependence. On these correlations and on that order is based *the system of the sciences*, which implies a unity. It is our problem to discover and define the order of nature, to indicate the grounds for these correlations, and to outline the system of the sciences both structurally as a system of reali-

ties, of relations, and of knowledge, and functionally as a system of studies, of utilities, and of services.

To attempt here a preliminary statement of this organization would be anticipating conclusions and would probably result in condensing too much in the compass of a few pages at the risk of incurring misconception thru lack of clearness. What should, however, be provided in this section is an outline — simple and clear, if possible — of the intellectual and developmental foundations of this intrinsic and comprehensive organization of science.

We study things by examining their parts and components and also their relations, and we often take them apart for the purpose; we dissect or *analyze* them. To put the things together again — that is another matter, and sometimes it is too much for us. To construct, to compose, to synthesize, we do not find so easy — to do these well or satisfactorily. If, however, we observe the relations pertaining to the things we are taking apart, and if we remember or comprehend them adequately, we may the more readily reconstruct them. It is a matter of relations of parts to parts and of parts to the whole. Often it is more simply the placing of like parts with like, for likeness is usually one of the simplest and closest of relations; but more often it is placing parts in proper, in significant, or in effectual relation to other *unlike* parts, which together compose a complex or system. Both of these processes, the composition or putting together of like components, and the construction of complex things from unlike components, both are termed *synthesis*, which thus is used — and sometimes confused — in two different senses.

Both usages obtain in scientific language, the former more often in psychological and educational parlance than in the natural sciences, in which the latter usage predominates. Synthesis, the antithesis of analysis, means usually in science the putting together of different but intrinsically related components, whether data, concepts, chemical substances, results of investigations, generalizations, theories, or re-

lated studies; and these components are regarded in essential, significant, or effectual relations to a complex or comprehensive whole. The components, whether like or unlike, must, however, be conditioned or qualified so as to enter into effectual or vital relations to one another and to the whole. It is a matter of relations; they are essential.

We study objects and problems, whether natural or human, not only by analyzing them into their components but furthermore by investigating their significant relations. Much testing and experimentation is for such purposes; much theorizing proceeds from the synthetic results. As the relations in which things exist and subsist are thru our investigations revealed to us more and more, we are gratified in that we know more about them and understand them the better. This is the theoretical and explanatory mode of our education and intelligence, of our science and philosophy. To know a thing in its essential, significant, and effectual relations, whether it be a bacterium, a coddling moth, a suppressed wish, or a marriage custom, is to have more understanding or intelligence of it. This truth obtains as regards objects of whatever order of existence or reality, natural, mental, and social, that is, thruout science and philosophy.

Here is a reason, a main reason, why scientific investigation goes on endlessly — as it seems. The relations extend to other fields; there are new relations, new aspects, we say, broader views. It is the enhanced appreciation of this scientific relativity and expansiveness — which is also a scientific predicament — that for the past two decades or more has been countervailing the tendency to "narrow specialization", which hitherto has so much impaired the intellectual comprehension of scientific minds.

What is true here of scientific objects small and great is true also of the sciences great and small into which their data enter; and this statement is not merely analogical; it is profoundly implied in the correlation of knowledge to reality.

A science, or a branch of scientific study, is distinct but not separate, is individual but not isolated from its fellow sciences; there is common ground; the same data, the same fields of study, may afford subject-matter for several sciences more or less closely related. Nor are the allied sciences as groups separate or unrelated to the other groups of sciences, fundamental or derived; there are interrelations; there is interdependence, as regards materials and methods. There are kindred interests and extending investigations. However special a study may be, however concentrated a specialist, the deeper the study goes and the more it gathers, the more it penetrates into other domains. The resulting breadth of view, understanding, and community of interest enhance the value of science to scientific minds. The specialist, mining deep, may also have broad views when he mounts the peaks of the mountain in whose recesses he mines.

A science is comprehended best in relation to other sciences. The sciences have definite relations to other sciences; there are groups, or classes, of sciences; there is an order, a gradation, a classification of the sciences. This, together with the relations involved, constitutes the *system* of the sciences, which has the coherence or unity of a system. "All of which makes us feel that the sciences are most scientific when they are most united. The higher the subject in the scale of being the more obvious this is, for Man most of all, but even in regard to the non-living the inter-relatedness of things makes a unification of sciences necessary." [13]

The coherence of scientific studies, the partition of scientific undertakings, the relationships of scientific associations, the application of scientific research, the embodiment of scientific knowledge and intelligence, these great interests are indeed best served by systemizing science with regard to the order of nature and the developmental interrelations of the branches. Such a unitary system is what we contemplate as the intrinsic and comprehensive organization of science.

[13] J. A. Thomson, *Introduction to Science*, p. 120.

CHAPTER IV

WHAT IS MEANT BY ORGANIZATION.

1. SOME RELEVANT DEFINITIONS.

Organ and organism are defined as correlative to function, and the several meanings of organization are distinguished.

We have been using the term *organization,* perhaps too freely, without having defined it. We should not postpone further the definition of the several meanings in which it may appear in these pages. To all kinds of readers the term is indeed familiar in many different uses. In the phrases "organization of knowledge" in psychological and educational usage and "organization of material" in the study of literary composition the meaning differs widely from the "organization" of an industry, government, or system of charities. All proper uses, however, have this in common that they mean *coherent* and *effective* relation of *parts* to the *whole,* the correlation of parts, or organs, to special actions, or effectual relations, or *functions;* and of the whole system to certain functions general or special.[1]

That *organ* is the correlate of *action* is implied in the derivation from the Greek word for that with which one *works.* This goes back of the biological correlate, *function,* which too may be defined in terms of *action* or *working,* and which is the source of several extended meanings. An organ is thus a bodily structure particularly adapted to some special function, as the eye, the liver, the larynx. The cell is the biological unit. Cells multiply and cohere to form tissues, and of

[1] "By an organic whole is understood one which (a) has a certain general character or individuality, while (b) it consists of distinguishable parts each with a certain character of its own, but (c) such that they cannot exist unmodified apart from the whole, while the character of the whole is similarly dependent upon them." Hobhouse, *Mind in Evolution,* p. 374.

these organs are formed. Organs and tissues, interacting in related functions, compose a system of organs, or *organism*. The gradual development, differentiation, specialization, and interrelation of its tissues and organs constitute its *organization*.[2] But another group of meanings is derived from the Greek. An organ is a tool, or instrument, or working part of a complex instrument, or machine. The word came into the English language first for a musical instrument, more especially that which we now call *organ;* but formerly the term was plural, and each pipe was called an organ. This usage survives probably in the distinctive terms for parts of the organ (groups of pipes, or of stops), the great organ, the choir organ, and the others. Then the working parts of an engine were formerly sometimes called organs. And so the functioning parts of a living body came to be called the *organs* of the body.[3]

The current extension of the term *organization* beyond the biological is therefore historically justified. Our definitions may accordingly be broader. An *organ* is a part that works or functions in effectual relation to other parts, or organs, and to the whole, or organism, or organization. An *organism* is a system of parts in which the relation of part to part involves a relation of part to whole; and this term usually connotes a system of biological functions. The original meaning, however, "and the ultimate meaning . . . is a system of tools and instruments."[4] An *organization* is a structure, or system, of effectually related parts, involving too some effectual relation of the parts to the whole.[5] The

[2] The correlation of function with structure in the organization of an organism is affirmed in the following passage from Conklin's *Heredity and Environment,* p. 208. "Function and structure are only two aspects of one and the same thing, namely organization. For all morphological characters there are functional correlatives, for functional characters morphological expressions, and if the one is inherited so is the other."

[3] This historical development may be traced in *The Oxford Dictionary.*

[4] *International Dictionary,* quoting Bosanquet.

[5] "And I believe that organization has finally become a category which stands beside those of matter and energy. . . . The fact is that for science the idea of organization, like that of energy, becomes established through a process of induction. It is today a component part of the theoretical description of nature, . . ." Henderson, *The Order of Nature,* p. 67.

organization may, or may not, be biological. The interrelation of the parts may not be so essential, or so vital, as in an organism; and the system may be less unitary. An organization is also the process of organizing such a system of interrelated parts. All thru these uses the idea of work, or function, inheres as correlative to the organ, or structure. A musical organ may be regarded as a structural organization, and an orchestra as a functional organization for the production of music.

There are thus three aspects of organization, the structural, the functional, and the developmental. In the organization of an army, corporation, or library it is the structure that is primarily meant, tho the special activity, function, or service is also implied. In the organization of a business concern, or of an interest, or a movement, it is the function that is regarded, tho here too some structure is implied, as in the organization of a textile industry or of a political campaign. In the term *organization of knowledge* the developmental is implied, but also the structural and the functional. There is a structural organization of mind in a sense similar to that of *organization of society,* in which all three aspects are implied.

Other special uses we shall here have little to do with. For instance, the term *organ* is by a current figure of speech applied to an organization's periodical publication, which speaks forth regularly in its interest, like a mouth or trumpet.

2. BIOLOGICAL AND PSYCHOLOGICAL IMPLICATIONS.

While functional organization of knowledge and of mind is affirmed structural organization in organized brains is merely implied.

Of the development of mind and the organization, or synthesis, of knowledge in the psychological sense it is beyond the purpose of this book to treat more fully. Nor shall we attempt to consider the confused and controverted definitions of consciousness, of mind, of knowledge, of truth, and of real-

ity. Our purpose would, however, be very much assisted, if these terms were consistently defined, and farther on the reader may find some rather definite statements regarding those elusive gates to philosophy. For the present suffice it to remark here that knowledge may be regarded as organic in the biological sense that it exists, objectively regarded, in organic, or organized, brains, and as in some way organized thru impression, memory, and experience, thru coherence, apperception, synthesis, and comprehension. The same may also be said of mind as correlative to knowledge, objectively considered, and as likewise at once individual and social. Subjective views are not here considered, nor those which merge, or confuse, consciousness, knowledge, and mind with the objects, or field of objects, perceived or known.

Biological study shows that organ and function develop interdependently, but structurally the organ is antecedent to its especial function; its tissues differentiate and its structure, tho rudimentary, develops to the organic stage before it begins to function with any evident effect.[6]

Psychologically, the assimilation and coherence of experiences are antecedent to the forming of concepts and complexes, and to the development of tendencies and dispositions, memories and habits. Brain, experience, knowledge, and mind, however, are organized concurrently and correlatively. Experience is the elemental content, somehow organized in the brain, while in the aspect of function knowledge is the more highly organized content of mind, and mind is the more highly organized content of brain. Mind, however organized, is synthetic, integrative, or unitary, both structurally and functionally. But the analogy should be less simple, as the reality is indeed more subtle. So, while

[6] Vitalistic writers sometimes argue that since life, or the vital principle, is antecedent to development and therefore to organs, it must be true that functions are antecedent to organs. Which functions? Certainly not those of the undeveloped organs. For a more positive statement see T. H. Morgan in *Science* of March 4, 1927, p. 216.

functional organization of mind is affirmed, structural organization of mind is, in view of our uncertainty, merely implied as correlative. The term *organization of knowledge* has, however, in psychological science been closely related to mental synthesis and development, whether in individual minds or in communities of minds.

But here psychology will be put aside for the present. We shall have to return to it in certain considerations in subsequent chapters; and we shall have to define what we mean by knowledge and by reality.

3. KINDS, OR STAGES, OF ORGANIZATION OF KNOWLEDGE.

We may distinguish: (1) mental synthesis, (2) social organization of knowledge, (3) the organization of a special branch of knowledge, (4) the organization of a field of knowledge in a class of books or other records, (5) the organization of many fields of knowledge in an encyclopedia or library. It is the last in its structural aspect as the classification of knowledge, or of books, that especially interests us in this book.

What concerns us here is that there are several kinds, or stages, of organization of knowledge: first, the mental, or psychologic, organization, or synthesis, of knowledge in an *individual* mind; second, the *social* organization of knowledge, and of thought, in a community of social minds,[7] in an educational field, in a science or a philosophy or an art; third, the organization, or synthesis, of a special branch of knowledge, or idea, or topic, embodied in a *book* or other form of written or spoken language; fourth, the social organization of a *field* of knowledge in a *class* of books or a *literature* or a *special library* or a *museum* or *exhibit;* and fifth, the social organization of many, or all, fields of knowledge and literatures in a conceptual system, scientific, intellectual, educa-

[7] This distinction between *individual* and *social* minds should not be misunderstood to imply that social minds exist as individual brains exist. With the psychologists Allport and Dunlap we agree that social minds exist only in individual minds. MacIver goes still farther in saying: "There are no individuals who are not social individuals, and there is no social mind that is not individual mind." *Op. cit.*, pp. 65–6.

tional, or cultural, in a body of literature, in an *encyclopedia,* or in a comprehensive library.

The forms, processes, and agencies for organizing and communicating knowledge other than those with which we are chiefly concerned in this work are surveyed in a clarifying outline in the first chapter of Dr. William S. Learned's book, *The American Public Library and the Diffusion of Knowledge.* "There are everywhere indications", says Dr. Learned, "that our American society is on the eve of a much more thoroughgoing organization of its intelligence service than has hitherto been attempted, and this too, primarily, though not exclusively, in the interests of adults." [8]

This movement is now manifested in the extensive services advocated and undertaken under the leadership and effectual organization of the American Library Association's Board on the Library and Adult Education, whose *Bulletins* have described many means and methods for functionally organizing knowledge thruout the several classes of people; and these methods would apply not only in America but eventually in many other nations.

The organization of the materials and knowledge of a subject of study, of a science, technology, industry, or profession, may assume any or all of the following forms (and probably other forms beside). In these several forms there are stages of development and more or less distinct differentiations, which may be indicated by distinctive terms.

1. Description, definition, or exhibition, of data, or materials.
2. Classification, tabulation, or arrangement, of materials.
3. Indexes, information services, etc.
4. Synthesis of related subjects, Systematic classification.
5. Educational organization of the subject and correlation to other subjects closely related to it.
6. Syllabi of the studies or subjects.
7. Curricula of the related studies in groups or courses.
8. Composite books, lectures, readings, collections.
9. Treatises and systematic studies, surveys, etc.
10. Introductions, text-books, manuals, compends, digests.
11. Histories of the sciences, studies, or subjects.
12. Bibliographies, catalogs, etc.

Historical and bibliographical organization of knowledge which is also selective and critical is exemplified in H. E. Barnes' *The New History and the Social Studies,* and also in the composite work edited by him, *The History and Prospects of the Social Sciences.* Setting forth the bibliographical data in historical relations and appraising them are effectual means to organizing the knowledge and thought that are embodied and expressed in

[8] *Op. cit.,* p. 8.

the books. In the second work cited above eighteen pages of the chapter on "Sociology", by F. H. Hankins, are occupied by an interesting "Classification of Social Theories", or of aspects of the subject-matter of the several studies of the social sciences. Not merely a classification of theories or concepts or aspects, this is also a grouping of the writers that have contributed to these organizations of thought. They are organizations of thought rather than of knowledge, for the scientific and historical knowledge is interwoven with philosophic reasoning and theorizing as well as ethical import or purport. The groupings moreover have historical and bibliographic values.

These forms and stages of the organization of knowledge again may be summarized otherwise as: 1, Descriptive, or exhibitory; 2, Classificatory, or analytic; 3, Synthetic, or systematic; 4, Educational, or cultural; 5, Bibliothecal, or bibliographical.

Closely related to these "forms" of organization are the methods of study and research that in relation to the processes of learning and the educational organization of knowledge we shall have to consider in the two following sections of this chapter.[9]

It is the classificatory, synthetic, systematic, educational, and bibliothecal that are treated of in this work, and more especially the culminating scientific, systematic, educational, and bibliothecal organization of knowledge in its structural aspect as the classification of knowledge and of books, rather than in its functional aspect as the education and information of minds and the bibliothecal and bibliopolic services to the users of books.

That this is not merely an intellectual interest but has social and economic value has been shown in the preceding chapters and will furthermore be shown in chapters to follow. It is not merely a bibliothecal problem, nor on a higher plane is it a problem solely scientific or philosophic.

[9] Charles E. Merriam's *New Aspects of Politics*, in a section, "Methods of Political Inquiry", of the chapter on the "Recent History of Political Thinking", gives for that special science a clear and concise account of the various methods of study, observational, descriptive, historical, comparative, statistical, analytical, logical, philosophical, psychological, etc.

It concerns all these and also the educational interests and those of social organization.

Concepts are synthesized and interlinked in knowledge and thought, which are recorded and expressed in language, and by language are communicated to many minds. Thought proceeds thru reason to new and more comprehensive knowledge and thought. In books thought and knowledge are communicated to all minds that have access. In libraries books are selected, classified, and preserved for present and future uses and for transmission of valuable knowledge and thought. This is the great progression from the dawn of knowledge to the day of progressive intellectual life in organized knowledge and thought.

4. THE ORGANIZATION OF KNOWLEDGE IN EDUCATION.

The various psychological and pedagogical usage of the terms implies closely related processes of learning and mental synthesis. The interlinked terms *apperception* and *correlation* are distinguished, and several authorities are quoted to exemplify the differentiations. These distinct kinds of organization are together essential to mental development and education. From mental synthesis there develop conceptual systems; and these become relatively consistent in the consensus of educated minds. Social and also liberal, this education is of highest importance to social and intellectual development.

In recent educational thought, especially in the more scientific study of education, which has become one of the most important developments of the first quarter of our century, the term *organization* is variously and vaguely used in analogies similar to those we have indicated in preceding pages. Some of these uses have psychological implications, some have pedagogical, and some have both together. Psychologically, organizations of experience, of judgment, and of knowledge are regarded as developments from the processes of perception, assimilation, association, memory, recall, concept formation, and mental synthesis. These processes arise from inherent mental resources, tendencies, and activities; but the mental products or developments depend no less on acquisitions from the extrinsic fields of experience. The se-

lection, assimilation, correlation, and "organization" of these mental resources and acquisitions becomes a major process of education. More broadly these processes may be comprehended as the development and organization of mind.

Pedagogically, the organization of similar experiences or relevant data of knowledge, of assimilative "subject-matter" in learning, is a process of bringing the *relevant* into *relation*, the correlated into coherence, the coherent into unity. This is more than a structural unification of inert parts; it is analogous rather to the assimilation of a responsive, functioning organism. The organized experience is functional, "instrumental", available. But this process depends not only on the mental resources, tendencies, and interests of the learner, but also on the mental resources and methods of the teacher. The educable mind in this organizing is both active and receptive; and the organization is at once a process and a product. The pedagogical implications are here combined with the psychological. The educative virtue and the efficacy of the method in learning and in teaching have justified the affirmation that organization is essential and intrinsically valuable to education, as it is to social and intellectual development.

The relation of the organization of knowledge on the one hand to the organization of experience, and on the other hand to the organization of thought, we touched upon in the third section of Chapter I. Here we will merely remark that those three stages of mental organization are of especial relevance to the study of education. Experience may be said to be the background of knowledge and thought its foreground. Education, to be valid and available, must develop knowledge in relation to and with proper regard to that background; and educated thinking proceeds — or should proceed — from well organized knowledge.

In the educational organization of experience, knowledge, and thought the several processes of assimilation, association, synthesis, learning, recall, thinking, and understand-

ing are interwoven, but they are in some respects sequential, assimilation being the primal, understanding the final stage.

The more elementary processes have since the days of Leibniz, Kant, and Herbart been variously comprised by the term *apperception,* which, however, has sometimes been extended to the higher stages of synthesis and understanding, as in the following definition by Lange: "Apperception is, therefore, that psychical activity by which individual perceptions, ideas, or idea-complexes are brought into relation to our previous intellectual and emotional life, assimilated with it, and thus raised to greater clearness, activity, and significance." [10]

The two ranges of the process are implied in Bagley's more recent book, *The Educative Process:* "This process of unifying and making 'meaningful' the data furnished by the sensation is known as *apperception.*" (p. 67) The primal stage he also calls "condensed experiences" (which he relates to concept formations, on pp. 139–50), and the synthetic products he terms "apperceptive systems". *Apperception masses* is the term used by others. Stages or "degrees" of apperception are distinguished by Bagley: "With continued development, fairly constant systems of experience come to be organized to which new experiences are referred. . . . Assimilation with reference to a primitive instinct is an apperception of low degree; assimilation with reference to an acquired need is an apperception of higher degree — the higher, the more remote is the need from the primitive instinct. . . . The business of education is to replace the lower apperceptive systems with those of higher degree — to develop the higher needs. . . ."

The progressive nature of these processes is also indicated by the following sentences from Professor E. N. Henderson's article on "Apperception" in Monroe's *Cyclopedia of Education:* "The teacher must prepare the way for instruction by finding what ideas the child already possesses which may constitute a basis for apperceiving the new topic. He must then so present this topic that it is readily seized by the consciousness thus roused to expect it. The successive topics that are presented must also be interrelated so that each throws light on the other. Method must bring out this connection. Hence a second step of method, or association. Associated material grasped together in a unity of reflection gives system, the third step in method."

[10] Lange, *Apperception,* ed. by De Garmo, Boston, 1896, p. 41.

[11] Bagley, William C., *The Educative Process* (p. 95), published by The Macmillan Company, New York, in 1905. Monroe's Cyclopedia of Education, from which we have quoted Prof. Henderson's article above and on pp. 84 and 88, was also published by The Macmillan Co., in 1911. These quotations, and also those from Bagley's book on pp. 85–6 and on p. x, facing the Preface, are reprinted by permission.

Correlation is another term that is involved in these closely related processes of education. "By correlation is meant", wrote Professor McMurry, "such a connection between the parts of each study and such a spinning of relations and connecting links between different sciences, that unity may spring out of the variety of knowledge." He continued: "Correlation . . . includes more than school studies. It lays hold of home influences, and all the experiences of life outside of school, . . . In the end, all the knowledge and experience gained by a person at home, at school, and elsewhere, should be classified and related, and each part brought into its right associations with other parts." [12]

"First is the close serial connection of ideas in a single study. Most teachers will admit that each lesson should be a collection of connected facts, and that every study, so far as it is a science, should consist of a series of derivative and mutually dependent lessons. This is based upon the idea of a natural scientific order or sequence of topics upon which the systematic framework of science rests.

"Second. Correlation is chiefly concerned with the relation of different studies to each other, assuming that the studies of the school course have been properly laid out. This is due to the fact that a great number of important relations actually exist between different branches. . . .

"Knowledge should not only be mastered in its scientific classifications, but also constantly referred back to things as seen in practical life and closely traced out and fixed in these connections." [13]

The correlation of school studies is clearly defined by Professor Henderson in the article cited above: "By correlation is meant such arrangement of the different lines of work in the school that the work of each constantly bears upon the work that is being done at the same time in other subjects. There are many schemes and degrees of correlation, but it is evident that the principle always is largely an application of the idea of apperception."

This subject in the broader aspect that has especial relevance to the interests of this book has by educators been regarded as of sufficient importance to become the charge of a special committee of The World Federation of Education Associations, pursuant to the resolution: "That the Federation inquire into the interrelations and increasing unifications of the various fields of knowledge and research toward a fuller and clearer co-ordination of subjects of instruction accordingly, with endeavor to bring about a greater unification of scientific terminology.

The recently established institute of Yale University for the syn-

[12] McMurry, Charles A., *Elements of General Method,* Macmillan, New York, 1903, pp. 162–3. This and the excerpt on p. 87 are reprinted here by permission.

[13] *Op. cit.,* pp. 167–9 and 189.

thetic, comprehensive study of humanity purposes a broad coöperative correlation of sciences and studies, not merely for the advanced results of research but for educational clarification of the knowledge and intelligence thus organized.

Correlation may thus, as a pedagogic method, be distinguished from apperception as a psychologic process in learning, the former depending on the latter, tho the latter may in its higher stages depend on the elemental stages of the former. The organization of knowledge broadly comprises both apperception and correlation, tho there has been a tendency in educational writings to use the term more specifically. Three quotations of especial interest will exemplify this usage.

"The organization of material is very important. In the presentation of ideas by the teacher or writer, organization is needed for clear understanding and mastery on the part of the hearer or reader. In almost all kinds of material there are intrinsic and logical connections which can be used for arranging the material. When the student makes any acquisition he will find it to his advantage to organize it, if it is not already organized; first, so that he can clearly understand it; second, so that he can recall it when he so desires. This logical organization is just the kind of thing that makes the results of learning superior to those of mnemonic systems. The intrinsic relationships among the facts are thus made clearer, which is precisely what it should be. Artificial systems fail to do this; indeed they may even lead one to neglect most significant relationships. The mastery of one who has command of a given field is largely due to the fact that he has organized his material; when he recalls, his facts are in groups, such as might appear in written form under paragraph, section, or chapter heads; when he learns new facts, they find their appropriate place immediately in his scheme of organization." [14]

"How the factor of organization operates in education may be clearly seen by comparing the old memoriter methods of teaching geography and history with the modern "rational" methods. Instead of memorizing a number of disconnected facts, the present plan is to emphasize the connection between facts, to show how each is related to the others, and how, through all, there runs a certain thread of unity which may frequently be formulated as a general principle or law."

"The Concentration and Correlation of Studies as a Means of Promoting Organization. That a thoroughgoing organization of

[14] A. S. Edwards, *The Psychology of Elementary Education,* pp. 78–9.

knowledge increases its revival value leads to the inference that studies in the school should be so thoroughly interrelated that each may form a unit in an organic whole. . . . Thus the entire elementary curriculum is built up, not as a mere mosaic of disconnected parts, but an organic whole centralized about a unitary "core" in such a manner that the relations of one part to another cannot fail to become apparent to the pupil." [15]

Logical organization is distinguished by Professor W. W. Charters from "psychological organization", by which he means the random and tentative assimilation or acquisition of subject-matter and the uncertain "groping" for correlation, order, or "control". "However, once the right plan has been discovered, the whole situation is re-examined and reorganized. The data are arranged in such a way as to produce the best organization, which is called a logical organization." [16]

But *psychological organization* sometimes implies "adaptation of subject-matter to the mental capacities and interests" of the learners.[17]

Professor G. D. Strayer likewise stresses the importance of interest:

"After the teacher has in hand an abundance of interesting material, the next step in the plan is to organize the data to be presented. Some organization is usually found in textbooks and courses of study, and it is possible simply to try to fit any additional material which may have been collected to the scheme provided. The difficulty with this ready-made organization is found in the fact that it has little or no relation to the needs or problems of the particular group of children to be taught. Any organization which is to be significant to children must take account of their point of view, and attempt to present subject-matter in response to the need which they feel for the material to be presented. This is precisely what is meant by the difference between the logical and psychological methods of presenting subject-matter." [18]

We may now come a step closer to the main interest of this book. The educational organization of knowledge comprises both apperception and correlation, and correlation ap-

[15] Bagley, *Op. cit.*, pp. 175–6, 179–81.

[16] *Methods of Teaching*, pp. 194 and 156.

[17] Parker, Samuel C., *General Methods of Teaching* . . . p. 141. Professor Parker distinguishes two principles for organizing subject-matter: "I. Intensive study of carefully selected large topics, instead of the superficial encyclopedic study of many topics. II. The organization of a subject psychologically, as children learn it most effectively, instead of organizing it merely in terms of the subject itself." (p. 115)

[18] *A Brief Course in the Teaching Process*, p. 168–9.

plies first to data or ideas in a single study, and then to the relation, interrelation, and coherence of a group, or groups, of studies, or of all relevant studies, in educational systems, scientific systems, and philosophic systems. In these systems some classification and order consistent with the order of nature is valid and applicable. If complete conformity be not feasible, if the educational purposes issue in divergent views and requirements, there should at least be no fundamental inconsistency between the pedagogic order and the natural or logical order. This question will be treated more fully in Chapter XII. But here the following passages from Professor McMurry's book should be of especial interest:

"Science itself, however, is related or classified knowledge. As already shown, it is the solid basis for the sequence of topics in those subjects that admit of scientific grouping and arrangement. There is no conflict between plans of correlation and proper scientific classifications; on the contrary, they are one and the same thing. It is only the narrow and exclusive grouping of the sciences, in total isolation from one another, that tended to weaken correlation.

"In the last few years the scientists themselves have taken a great step in advance by abandoning the narrow and strict classifications of a generation ago, and by treating each topic broadly in its relations to other sciences and studies. . . .

". . . There is a resistless tendency to convert the course of studies into an encyclopædia of knowledge." *Op. cit.*, pp. 193–5.

The order and correlation of studies in curricula may have less regard to the scientific and logical grounds than to the historical and developmental relations, which are sometimes quite distinct, however interrelated the subjects may be in their realities. The differences between the developmental and the pedagogic order will also be considered in Chapter XII.

There is a theory called the "culture epoch theory" that goes farther in this direction. It is a theory that may have been overworked, but it still seems to maintain a degree of currency, tho modified. It of course applies to the elemen-

tary stages of apperception rather than to the higher stages of correlation.

"According to this theory, the studies should be presented to the child in the order of their appearance in the history of the race. Thus the child will be led through a series of "culture epochs" corresponding to those in the history of civilization. The justification for this order of study lies in that it is supposed to be the order of clearest apperception on the part of the child. . . .

"The second consideration that led to the culture epoch theory was that of psychological recapitulation. . . . According to it, the child manifests successively certain instincts. These instincts appear in the order of their racial evolution. Upon them depend the child's interests and activities, and upon interest and activity depend his ability to apperceive." Henderson, *Loc. cit.*

The reorganization of curricula is regarded as one of the outstanding problems pressing for immediate undertakings in the interests of education for social adjustment and amelioration. It seems likely that in such reorganization there may be some effectual adjustment of the pedagogic to the logical and scientific order of knowledge.

But the broadest view is that the educational organization of human experience and knowledge should have adequate regard for its grounds in nature and human nature. Human nature is continuous with the whole of nature, and the natural, humanistic, and pedagogic orders should be consistent. This consistency should appear thruout the entire process of educational organization.

Education is thus largely an organization of experience and knowledge,[19] in which the immature mind is prepared for life and the mature mind is continuously developed and enriched with organized thought and purpose. To be clear and effectual in social intercourse and in business, in science and philosophy, in ethics and æsthetics, this organized thought and purpose should arise from well organized knowledge.

[19] Professor Dewey has thruout his educational leadership stressed the relation of learning and knowledge to the organization of experience. See for instance *School and Society*, pp. 15–28, also 137.

5. ORGANIZATION OF KNOWLEDGE IN MUSEUMS AND EXHIBITS.

In museums and exhibits concrete objects of knowledge are shown more directly and vividly than in books and pictures. The purposes are largely educational. Some of the methods are indicated. Classification, synthesis, and system are essential. In the future closer coöperation within the several fields seems likely, and also with educational institutions. Such organizations of knowledge are evidently destined to become greatly more important.

A fundamental distinction obtains between knowledge and the objects of knowledge. The correlation, however, is close and is sometimes confusing to common sense, while to philosophers the implied subject-object relation has long been a most troublesome problem, to which we shall have to cast a philosophic glance in a later chapter. What concerns us here is that in museums and exhibits we deal with objects more directly than in books and pictures, descriptions and mental images; and the objects exhibited are intended to be *objects of knowledge.*

Objectively they are more vivid, especially to minds more interested in concrete things than in concepts. The graphic and imitative objects are closer to the nature they represent; the art objects are actually expressive of their respective arts; the natural objects are nearer to life; the biologic, tho not living, may be shown in the semblance of life — life-like. "Why, mother, this is a dead circus", a little girl was heard to say in a zoölogical museum.

Knowledge, the inculcation and dissemination of knowledge, is the main purpose of these exhibits, tho they may also serve to please and entertain. But the knowledge is not mere information of facts regarding discrete objects; the better exhibits are professedly educational, the higher aims being to inform the understanding, to cultivate tastes and appreciations, and consequently to afford pleasure and entertainment.

There are many kinds of museums and exhibits, and many methods of exhibition. But mere collection and arrangement in halls and show-cases do not suffice where educational

aims are purposed. This applies to museums for study or research in sciences, in arts, or in industries, as well as to exhibits for the information, education, and entertainment of the people and the children of the people. The objects collected and exhibited must be labelled and described; they must be selected, classified, grouped, and arranged with especial regard to the interests to be served and the ideas to be inculcated. In the methods of exhibit special art and a high order of ability are sometimes appreciable. Fuller instruction may occasionally be given and lectures may be delivered. The arts of exhibition and graphic representation may extend into higher educational arts.

An insect or flower, too small for unaided observation, may be magnified in an artificial model or imitation, or in a chart. The giant *Sequoia* may have a cross-section placed beside a photograph of the entire tree in its native habitat. The skeleton of a mighty *Brontosaurus* may be shown beside an imaginative painting of the ontological past of that species. The embryonic development of a human being may be exhibited in stages that are plainly transitional. For those who otherwise may not trace the course of evolution there may be arranged specimens or models or "evidences" of a succession of evolutional types. Historical, archeological, anthropological, and ethnographical collections may be made to tell more vividly than books, to illustrate more adequately than pictures, the stories of those vistas of the history of mankind. For those who may not travel, the geographic, ethnographic, and ecologic environments of natural and of human life may be constructed with scientific and also with æsthetic verities. The products of many arts and many lands may be brought together in one room in more significant groupings than would occur to the minds of even observant tourists and intelligent travelers. The industrial and civic arts that are all about us may in such exhibits be disclosed in operation — things of which we have in a sense heard or known but have not had serviceable knowledge.

Significant social, economic, and industrial facts, statistical or historical, may be summarized in charts or other graphic representations. Particular instances illustrating those summarized facts may be shown in photography or in a selection of typical specimens.

In museums that are well administered and in exhibits that are well "organized" educational aims and methods such as we have outlined in the preceding paragraphs have been adopted, and they are being appreciably recognized by the people whom they benefit.

Considering the correlation of knowledge to the objects of knowledge, we may regard those well-organized exhibits as virtually organizations of knowledge. As such they depend on classifications and on system in dealing with the manifold relations that may be involved. As in purely conceptual organizations of knowledge, the classifications, the relations, and the systems should be relative to the interests and purposes that are to be served, whether scientific, historical, sociological, educational, or cultural. In museums and exhibits of comprehensive scope, covering many fields of study and interest, the system may well be made consistent with the system of the sciences and the interrelated studies. This is especially important for those museums that are purposed to serve scientific, technical, and industrial studies; but it is also material for those that are broadly of educational and cultural value, for the special arts and educations are intricately dependent on and interwoven with their respective scientific studies. These truths will in subsequent chapters be made plain for those who do not sufficiently appreciate their validity in the foregoing statements.

Progress in such organization of the objects of knowledge as we have just contemplated has been rapid in the recent past. In the future it seems likely to become much greater, while socially and culturally much more important. The movement of adult education will probably require extensive coöperation between educational institutions and museums,

as now it is found to require the organized coöperation of libraries. Such relations would likewise develop into forms of organized coöperation among museums and other educational exhibitions in the same fields. These forms might extend to such economies as loaning exhibits that might be transported more economically than they could be independently "organized" and elaborated. In the internal economy of the institutions there might be coöperation in such branches of administrative work as classifying, labeling, and describing the objects and exhibits. Specialists in one institution might extend their services to sister institutions. In some fields certain printing might also be coöperative. These things, now in the inceptive stages, seem likely in the future to attain to very extensive developments. Such organization of these special means to organizing knowledge in museums and exhibits would seem destined to become a very important sector of the comprehensive, world-wide development of the organization of social knowledge.

CHAPTER V

BOOKS AND LIBRARIES.

1. KNOWLEDGE ORGANIZED IN BOOKS AND IN LIBRARIES.

Synthetically and socially organized, knowledge and thought are embodied and communicated in records and in books. Like a tree this body takes on new growth, but its main structure persists. The progressively organized system of knowledge and thought is progressively and systematically embodied in classified collections of books in libraries.

Knowledge is organized developmentally and synthetically in *individual* minds. Socially it is organized in communities, in schools, and in systems of education, of science, of philosophy, and of morals. Special knowledge is coöperatively organized in the several distinct sciences and technologies, industries and professions, trades and arts. General knowledge is organized, tho imperfectly, in comprehensive books, in encyclopedias, in libraries, in curricula, and in comprehensive minds.

Organized knowledge is not merely the priceless possession of communities of intangible minds, or of perhaps uncommunicative individual minds; it is expressed and recorded in language, written and printed, and is embodied in books, accessibly and imperishably. For the knowledge in books is more permanent than the books in which it is embodied, more permanent even than the language in which it is recorded. Like a spirit indeed, this immaterial product of mind passes from thought to thought, from tongue to tongue, from book to book, from age to age. What is false, what is invalid, is in time omitted or cast out, but what is true and what is new and valuable are combined and handed on in tradition and in

literature, in a perduring body of progressively organized knowledge.

The forms and features of this body may change from time to time; its organs and functions may vary with human pursuits and intellectual interests; like a branching tree it may grow more to this side or to that, or may lose a bough or a branch from above or below. New leaves and twigs come yearly to all its live branches; they clothe with fresh verdure the growth that has arisen thru the ages. New spirits may pass like the breezes to stir those boughs, while the birds, or the song of the birds, may wing from the dell to the dale. But the tree stands thru the centuries, and thru all changes of growth and circumstance its main structure and its conformation persist.

Common knowledge, the acquaintance with things in the world about us, the inherited and habitual modes of doing and making things, of thinking and of expressing thoughts and emotions, these forms of organized experience, opinion, and belief are largely traditional and admit of too little spontaneity. They lie like the waters of lakes with only a few rills flowing in from the spiritual sources of the uplands and still fewer outlets for the active, progressive streams that are ever seeking new levels and new prospects.

This progressive spirit is essential to the development of life and is one of the most precious possessions of humanity. With it knowledge and thought have expanded, thought ever gaining new knowledge, new relations, and new interpretations; ever attempting, experimenting, and comparing, ever doubting, discarding, and reorganizing, ever appraising, verifying, and validifying. This is the illimitable process of rational thought and knowledge, of which literature, science, and philosophy are concurrent streams that bear the human intellect to its vast destinies. This system of knowledge and thought is progressively organized in successive books, and more systematically in classified collections of books in libraries. But the relative permanence of the organization

and the classification will depend not only on its structural coherence but no less on its adaptability to the progressive functional life.

2. ORGANIZING KNOWLEDGE IN THE PUBLISHING OF BOOKS AND JOURNALS.

The services of publishers to intellectual and educational interests are appreciated. They may be regarded as aiding the organization of social knowledge. Several modes of this relation are indicated. In books and in the various kinds of periodicals there is a process of organizing knowledge, which may be purposive and systematic. This applies to special "organs" and also to "journals of opinion", and even to newspapers. The literature of influence is not wholly distinct from the literature of knowledge. Books of "humanized" science are being published in increasing numbers. This is a momentous tendency in the organization of social knowledge.

The institutions and agencies for organizing social knowledge would not be completely accounted for, if due credit were not given to the publishers of books and journals. Authors and readers have so often learned that most publishing is a business of costs and profits, of selling and advertising, that they are perhaps too likely to overlook the social credits of this business. These on the other hand have, it would seem, not only largely compensated the world of readers and of authors but have liberally overpaid the social and economic obligations. This is demonstrably true of the past, and it is probably true of the present, if all values be fairly considered.

Some publishers of commercial literature and some of grossly profitable journalism may indeed have exploited their fields outrageously. They may have failed to meet immense social responsibilities for the mental and moral uplift of the masses and classes that have been so largely dependent upon their products. But, while exploitation in these fields has probably been no more unsocial than in other fields of business, the products have been on the whole beneficial, even if only in leading these masses and classes, at least in some measure, to read and to think. Then other publishers have been less commercial, have been more considerate of social,

ethical, and æsthetic values. These have rendered inestimable services.

The first printers were — most of them — lovers of men and of books and knowledge; they were amateurs in the noble sense. The early publishers were often enthusiasts. All thru the centuries of enlightenment the makers of books, authors and publishers, were like a brotherhood. The debit side, it is true, counts many instances of sharp dealing, theft, and extortion; but on the credit side there are probably as many instances of friendly aid and shouldering of pecuniary losses. In computing these balances we should consider that the recognized mental and spiritual compensations of the publishers have in terms of fame, influence, and other intellectual values been very much less than those of the authors; and often, where the immediate financial losses to author and publisher have been considerable, the eventual spiritual gains to humanity have been very great.

But it is not these assets and liabilities that especially concern us here; for these may be regarded as merely incidental to the business of publishing knowledge and thought and news for public demand and consumption. It is the manifest tendency of modern publications to *organize* knowledge, whether special or general in content, — it is this tendency that comes within the scope of our survey. In this development the publishers are coöperating, directly or indirectly, with the educational institutions, the universities, the scientific and economic associations, the libraries and the museums. A vast system of informal organization is thus developing, in which the publishers of books and journals have important place and purpose.

The forms of this organization of knowledge are becoming more definite, and the products more valuable. First, there are the great, comprehensive encyclopedias and dictionaries. Then encyclopedic works, often in many volumes, are more or less systematic. The most notable systematizers in this form have been the German publishers, tho of course some of

the credit should be shared with the editors and authors that have collaborated in these great publications. More recently American, English, and French publishers have been producing collaborative and collective works in nearly every field of interest. Scientific and educational institutions have been supporting, usually upon liberal philanthropic foundations, extensive publications, whether serial or systematic, organizing knowledge with educational or humanitarian purpose.

The publisher's relation is more distinct in the publication of series of volumes not editorially connected but related in interest whether social or scientific. Often these series are advertised under distinctive names and are regarded as having a kind of systematic coherence. The several books may in their contents and in the treatment of their subject evince the purpose to organize social knowledge.

But, as in museums, mere collection is not adequate to the purposes; system is requisite — synthesis and system. In this there is a marked tendency to follow the systems of science and education as conceived and maintained in the consensus of educated and scientific minds.

In a certain sense any good writing "organizes" its material. This meaning of the term harks back to the educational usage, which we considered in the fourth section of the preceding chapter. In so far as the publisher selects books with regard to this quality and in so far as the publisher's "editor" advises and revises with this regard, the publishers may be said to serve as organizers of knowledge in books.

In the publication of "journals" there is enough of similar selection and revision with respect to the interests of the field to justify extending to these publications too the attribute of organizing knowledge. The general name *journal* is here used in the loose sense that has strayed away from its etymology, and which we essay to define as a *periodical publication issuing the news of its field,* that is, reporting the occurrences, recording the transactions or proceedings, surveying

the progress, and publishing, reprinting, or abstracting important recent contributions to the knowledge and thought of its subject or field of interest. Tho issued — not daily — but weekly, monthly, or even quarterly, these journals may be comparable in function to those that serve their interests daily. "Trade journals" in some special fields and "official organs" for associations and institutions are representative of a constituency, and they may evince effectual leadership. Their policies may be educational, for the information and cultivation of special interests. Systematically representing organizations, they may in truth be regarded as organizing knowledge in their several fields, whether scientific, technologic, or industrial, commercial, social, or humanitarian, historical, academic, or artistic.

In the larger sense too, systematic publications of groups of periodicals, especially when combined with bibliographic or abstracting services, may be regarded as organizations of knowledge. One notable instance is that of the well-known Wistar Institute for the advancement of biological science, which on a very liberal foundation publishes at present twelve journals of biological, anthropological, and medical interest, which otherwise might not be self-sustaining. Moreover, the articles in these journals are card-cataloged as to both authors and subjects, and on the backs of the subject-cards are the authors' prepared "abstracts" of their contributions, the whole "bibliographic service" being supplied for a small yearly subscription. Furthermore, a classification of the subjects is provided for interests to which this may be of value. This indeed is an organization of knowledge in the broad bibliographic sense.

Less systematic than the "organs" of special fields are the weekly and monthly "journals of opinion", which extend more generally to wide interests in public affairs, social, political, and economic. The relations of these publications to their several "publics" are usually less definite; their policies are not commonly explicit; their leadership may be more

consciously politic; they frankly admit that they are comparably and necessarily commercial. They must pay for the talent they employ. For their profits they must depend on the extensive and lavish advertisement which American business experience has found so highly profitable. To gain this advertising they must hold a large constituency of readers. But, since large groups of readers will probably have in their midst many individuals, or groups, who desire more knowledge and better criticism, there is an inherent tendency to supply this and therein to educate and uplift the mass to higher planes of thought and understanding. These publications consequently become more or less professedly educational, and they advance to organize more or less systematically the thought and opinion, and sometimes the purpose of their constituencies.

Even in the daily "press" there is in evidence to some extent a higher journalism of information and education that may be regarded as virtually an organization of social knowledge. Those who read the facts of the daily news and the "stories" of the Sunday "sections" may perhaps by virtue of the marvelous capacities of the human mind "organize" these crude materials into knowledge of the world and of human affairs. This process, however, comes nearer to the unintentional psychological processes of *mental synthesis* and organization of every-day human experience and common knowledge. It is the educative ounces of this journalism that may justify the mailing at the second-class rate of the millions of pounds of advertisement on which the superior purveyors of news so magnificently prosper. But in truth news is knowledge, that is, true news may be organized into knowledge, and thus it may become not merely informative but educative. In fulfilling this implied obligation and their social responsibilities, the newspapers should indeed serve these educational interests more effectually than they do at present, and on a higher educational level.

The gathering and distributing of news to newspapers is

indeed well organized by the press associations, news agencies, and newspaper syndicates, the most notable of which are in the United States the Associated Press and in Europe the Reuter Agency in London, the Havas Agency in Paris, and the Wolff Bureau in Berlin. The Associated Press is a cooperative organization, and the European agencies are also more or less coöperative.

A most important undertaking to supply newspapers and journals of opinion with accurate and well organized scientific material has been successfully developed in the Science Service liberally established by the late Edward W. Scripps, with magnanimous humanitarian and educational purposes.

"Science Service is the concrete expression of E. W. Scripps's belief that through it Science and the Profession of Journalism may unite with great effectiveness in educating the rank and file of the community in . . . the sciences of human life itself, . . . To him the daily newspaper was as truly an educational agency as the school. . . ." [1]

The organization is composed of fifteen members and trustees, of whom nine are scientists, three from the American Association for the Advancement of Science, three from the National Academy of Sciences, and three from the National Research Council; and six are not representative of scientific organizations, at present three being journalists and three representing the estate of the founder.

Science Service now publishes a *Science News Bulletin,* which is "a daily syndicated series of brief non-technical articles on new discoveries, inventions and events . . ."; *Feature Articles,* illustrated, a weekly service; *Special Newspaper Features,* reporting important scientific events; *Science News-Letter,* a weekly magazine published for the benefit of teachers, librarians, and others; *Science Shorts,* for filling out columns of newspapers, issued weekly; *Nature's Notebook,* an account of happenings in nature of seasonal interest; a monthly *Star Map,* or chart of the heavens for star-gazers; *Why the Weather,* explanatory, a daily syndicated series; and in addition to these a telegraphic service is maintained reporting to newspapers events of scientific importance; and a radio talk is broadcast weekly on scientific subjects. Furthermore to periodicals the Service offers to supply "magazine articles" of any specified style and length; and the Service is extended even to

[1] From a tribute by William E. Ritter, President of *Science Service,* presented to the Trustees, April 1926.

"the writing, editing, revision, and criticism of manuscripts" of books and articles.

The popularizing or "humanizing" of knowledge is one of the most significant present tendencies in the publication of literature. This tendency has perhaps been accelerated by the notable address by James Harvey Robinson before The American Association for the Advancement of Science in 1922, entitled "The Humanizing of Knowledge". In the past there had been several movements toward popularizing scientific knowledge in series of books and of lectures; but recently the tendency has received renewed impetus and publishers are vying with one another in disseminating humanized scientific knowledge. It seems to be paying — both publishers and authors; and consequently authors of scientific attainments, and also literary, are giving their talents to these interests. There is immense significance in this, and momentous social consequences are evidently ensuing. This is perhaps the most important aspect of the publishers' relation to the organization of social knowledge.

3. FUNCTIONAL ORGANIZATION OF KNOWLEDGE IN LIBRARIES.

A few general statements regarding this broad subject have place in this section. Structural organization of knowledge in classification of books and pamphlets is the main subject of a second volume — with regard, however, to *functional* organization in *groupings* of books for various uses. The functions of subject catalogs and bibliographies, of reference librarians and information services, are also treated in certain chapters of that volume.

Of the several kinds or modes, structural and functional, of the organization of knowledge, which were named in the third section of the preceding chapter, there are certain that are especially developed in library services. First there is the bibliothecal function of supplying books for courses of reading or study, whether within the libraries or beyond their walls. Courses of reading may be offered by the librarians with or without the coöperation of educators. This service is intrinsically educative and it may be more or less sys-

tematic; it tends to become more so. Indeed the purposes and undertakings of librarians and library organizations have during recent years, particularly in the United States, become professedly and professionally educational and "organized". The movement has moreover been spreading abroad, in England, in Germany, in Czecho-Slovakia, and in other countries. In America one special extension of this immense social service has combined with the preceding educational movements known as university extension, adult education, and workmen's education. "Adult education" has been one of the leading interests in the American Library Association for the past two or three years and has been the charge of one of its most important commissions.

For children, various educational services, comprising not only the selection, display, and arrangement of books and magazines, but also story telling, supplying pictures, and exhibiting motion-pictures, have for years been well organized in many public libraries, and the educational benefits have been liberally provided for and appreciatively recognized. It hardly seems necessary to restate the relations of this field of service to the several forms of educational organization of knowledge, which we considered in the fourth and fifth sections of the preceding chapter.

Other well established bibliothecal functions are those of the reference librarian and the information bureau, which do not come especially within the scope of this book, but which in certain aspects will be noticed in another volume. In these services the functional organization of resources is prerequisite to efficiency. The dependence on classification and index, on bibliography and subject catalog, on shelf-list and filing system we shall later find to be fundamental. The extension of these information services beyond the individual library tends to become a very important coöperative organization of resources and facilities.

As regards bibliographical methods, the catalogs (of several forms), the "finding-lists", and the bulletins of special

resources and of new accessions are means to organizing knowledge which also will be considered subsequently.

It is the classifying and grouping of books for the various uses of readers and librarians that — as we have said before — is one of the main purposes of this study, and especially to promote the study of more serviceable and efficient classification as a major problem of library service and as a most important means to the functional organization of knowledge.

4. CONSERVATISM IN CLASSIFICATION FOR LIBRARIES.

Library classifications have not conformed to the scientific and educational organization of knowledge. The reasons are historical. Wherein the several practical classifications, the American and the European, have failed is briefly shown. The establishment of certain American systems has fortified conservatism. In other respects, however, American librarians are progressive, and their interest should now lead them forward in the progressive organization of knowledge.

Considering the extensive development of libraries during the past half-century and the educational purposes that have carried library organization into a wide range of valuable services, we should expect to find the classification of books in libraries consistent with the organization of knowledge and the order of the sciences as conceived in the scientific and educational consensus. That this is not so is evident. The reasons are not difficult to ascribe.

The arrangements of books in libraries have been determined by historical and economic conditions rather than by the intellectual and scientific interests that have inspired the books and the readers, and also the librarians. The classification of books, it has been urged, should be simple, specific, and practical. Scholars, scientists, and philosophers will have their books in their own ways; but the people, who study few books and may even lack education, have little need for systematic classifications. Libraries that are free to all the people must provide for the masses, for demands which they can meet only by stinted economies. These demands increase out of proportion to funds and appropria-

tions. Elaborate classification, however desirable, costs more than these conditions allow librarians to expend for it.

Practical considerations such as these have prevailed in the administration of public libraries in America and Great Britain, and they have obtained even in the libraries of higher purposes, including those of educational and scientific institutions. They still obtain, for economies are with us always. But during the last two decades of the nineteenth century the professional spirit of American librarianship arose on a great ideal of social service that transcended the social conditions and even the requisite economies. Women librarians could and would serve for little compensation other than what they found in their love of books and their love of readers and of children. If classification served their good purpose, they would adopt it and work to that end with zeal.

The leaders in library development were urging that classification is indeed valuable, when in the middle eighties the Decimal Classification, published by Mr. Melvil Dewey in 1876, was proving very serviceable in many libraries. It filled in its way a need that was beginning to be felt. It seemed simple and practical and admirably adapted to the principle, proclaimed by its author, of *movable,* or *relative,* location of classes of books on the shelves and consequent *expansibility.* Its numerical notation, with its decimal principle, and its "Relativ Index" were highly appreciated. Indeed notation and index were so enthusiastically welcomed, that there was too little consideration for the main object, classification. The tail was wagging the dog. The rapidity of its success was indeed phenomenal. A happy dog's tail is irresistible. The D.C. had become in a decade from its inception the unrivalled exemplar of library system, and the object of indiscriminate affection and admiration. In another decade it had become the glory of the great library movement in America. In a third decade it had sporadically rooted in Europe. Its prestige was enhanced by its quali-

fied adoption by the International Institute of Bibliography. For the Arabic notation is international, and in nearly every country of Europe metric standards are decimal. Then the system was ready at hand, complete and indexed; and no other system in print satisfied these important requirements.

This remarkable success was indeed not without opposition. There was criticism and controversy. This centered about the Dewey system, but it involved the whole question of classification, the limitations of which were well stated by Mr. W. I. Fletcher, for many years the esteemed editor of the famous Poole's *Index to Periodical Literature.*

Among the critics of the Dewey classification in the earlier period were Mr. F. B. Perkins, of San Francisco, and Mr. J. Schwartz, of New York, who jointly contributed to *The Library Journal* for February, 1886, what they called "a duet" on "The Dui-Decimal Classification and the 'Relativ' Index". Mr. Dewey, an advocate of spelling reform, for a time went so far as to spell his name Dui, and he continued always to spell his forename without the two superflous letters that are customary. Mr. Dewey was defended by Mr. C. A. Cutter, the most creditable champion of classification in those days, and then editor of *The Library Journal.* This suave writer, referring to "the duet" and reminiscent of a Latin declension, facetiously interposed that *Dui* was not so much in the wrong as *Duo.*

Mr. Cutter was then preparing to put forth, quite modestly and not too controversially, his own system of classification and notation, which he termed *Expansive,* and to which he had drawn attention five years before. The Expansive Classification, constructed first for The Boston Athenæum in the early eighties, was professedly practical rather than scientific, and its author then expressed more interest in the notation than in the order of the subjects, even as Dewey had done. This classification, however, has since come to be regarded as especially scientific and logical and as comparatively free from the strictures drawn against the Decimal

Classification and from its obvious inconsistencies. This system has been adopted in a considerable number of libraries, and has achieved, as a later critic phrased it, "a certain *succès d'estime*" as compared with the *succès populaire* of the Dewey system. But how far from incorporating the system of the sciences it really is we will show in a subsequent volume. Explicit criticism of the Decimal Classification and of other systems is also deferred. The present purpose is but to declare the failure of American librarianship to produce a classification in conformity with the scientific and educational consensus.

In European libraries there had been several attempts at logical or scientific order, but for catalogs or bibliographies, not for classification of books on the shelves. Readers were usually not given access to the shelves. The librarians did not feel the need of classifying the books, and the principle of movable location did not obtain there. If the classification of books was mostly practical and arbitrary in America, it was almost wholly so in Europe.

The French term *Catalogue raisonné* (analogous to *Dictionnaire raisonné*) came to be applied to classed catalogs. That of Merlin, published in 1842–7, deserves to be mentioned with praise. Edwards' *Memoirs of Libraries* gives a synopsis of this and of other notable systems. Brunet's *Manuel du Libraire,* published at Paris in 1810, had long been a leading authority, and was elaborately classified by subjects. The System of Classifying Books in the British Museum dates back to 1836. In Germany Hartwig's *Schema des Realkatalogs der K. Universitätsbibliothek zu Halle a S.* was published in 1888 and has since been regarded with considerable appreciation, but it does not satisfactorily embody the modern system of knowledge.[2]

Unlike the stately and venerable libraries of Europe, the great national library of the United States has risen in immense and rapid development, but under conditions that have hindered classification on a scientific basis. However

[2] Richardson's *Classification, Theoretical and Practical,* New York, Scribner, 1912, mentions sixteen systems published in Europe between 1880, the date of the great *Catalogue général de la libraire française* of Lorenz, and 1890, the date of Bonazzi's *Schema di catalogo sistematico per le biblioteche.*

much of science may have been put into the library and into its classification during the past quarter century of its colossal growth, this classification is far from satisfactory as an organization of knowledge; for it is not based on the order of the sciences. This too will be shown in the other volume.

The leading modern English system, that of Brown, may be free from most of these objections, but those that apply to it especially are no less weighty. It combines science with technology in an impractical manner; it separates History from Social Science by the immense mass of all the languages and literatures, and it misplaces Philosophy. Moreover, its classification of science is very unsatisfactory.

These systems in America and England, having adopted the principle of *adjustable, expansive classes and notation relative to these,* have proved the feasibility of adaptive subject classification on the shelves. The value of this principle has long been affirmed by librarians, with but few dissenting voices, and this affirmation continues to be sustained.

Subject classification has been found practicable, but it is practical classification — that is, simple and convenient for present uses — that has been advocated. There has been little consideration for any higher order of knowledge, logical or scientific, natural or pedagogic. The systems mentioned had been constructed on a practical, that is, arbitrary, or artificial, basis,[3] according to the ideas peculiar to those individual librarians who had constructed them; and they had been adapted to the conditions of their particular libraries. If the conditions in Amherst College in the decade of the seventies, if the conditions in The Boston Athenæum in the eighties, if the conditions in The Library of Congress in the late nineties, were not conducive to a consistent scientific organization of knowledge, if the minds of those estimable classificationers who constructed those three systems were not informed of the great organization of knowledge and thought

[3] These terms have definite meanings which are stated in Chapter VIII, § 4.

that developed in the last quarter of the nineteenth century, then those arbitrary classifications were from their very origins likely to prove inadequate, unscientific, and temporary. That they were so conditioned and disqualified from their origins and that their subsequent development, elaboration, and extensive application have not appreciably modified their fundamental inadequacy it is our purpose later to substantiate. We shall find that it would have been more practical to have been more scientific. This moreover is as true for the future as it has been for the past. For now that the systems are established, conservatism, with proper concern for economy, opposes any substantial progressive change.[4]

But American librarians have not been conservative in other respects; and they are not likely to remain conservative in this, one of the highest of their professional services; for hardly less important than the selection of books is the classification and grouping of books *with regard to their contents and the interests in which they are most likely to be used for good purposes*. If American librarians are indeed professionally progressive and if service is indeed the ideal of their profession, will not their professional interests in serving progressive communities lead them forward with the great movement of the progressive organization of knowledge?

5. BETTER CLASSIFICATION DESIRED BY SCIENTISTS AND BY LIBRARIANS.

Scientists and educators have good reason to be dissatisfied with library classifications. Librarians are more particularly critical of the classifications in use in libraries, but of recent years they have been more intent on other problems. Now, however, the value of organization of knowledge is indeed recognized, and the problem of classification for libraries should be earnestly reconsidered.

While scientists and educators appreciate the values of library services and expatiate upon the importance of their great development in the United States, they dispraise the

[4] Typical of this conservatism is the following dogmatic pronouncement of one of the most respected leaders of the older generation, in a contribution entitled "Principles of Classification", which in the *Proceedings* of the A.L.A. Conference in 1917 preceded, with other contributions to a symposium

classifications in vogue, that is, those do who give any attention to the matter. "It is an unsettled question whether eternal war is foreordained between science and libraries," wrote a scientist, commenting on the Library of Congress' classification of the Social Sciences. "Classification there must be," he petulantly continued, "but in the case of every vital science it seems impossible to propose a classification of books which is not more or less in contradiction of relations which are obvious to every investigator." [5]

This expression is querulous and extreme, but as representative of workers with books, it should be considered. Very mild, on the other hand, is Dr. F. L. Hoffman's remark before a meeting of the American Association for the Advancement of Science: "In the same sense it is a safe statement to make that the practical value of a public library at the present time is but a fraction of its possible utility were it properly conceived on the principles of organized knowledge." [6]

An anthropologist, Dr. Juul Dieserud, who was also a librarian, writing in 1898 on the Decimal Classification, with regard to revision, asserted that ". . . at the present date it is in part entirely antiquated and certainly stands in need of a thorough revision.

"It is therefore a mystery to many how librarians here and abroad could seriously consider the advisability of introducing the system unchanged in the great international bibliographical undertaking.[7]

". . . The American library profession is assuredly now capable of developing something better, and owes this to its

on the subject, a paper in which the present writer *did* briefly state, in a preliminary way, some *principles* of classification. "An American library should adopt", said the conservative, "one of the three systems most generally used in this country, and it would be a woeful waste of time and energy to attempt to construct a new one in the hope of avoiding the many defects of the existing systems. Our efforts, therefore, should be devoted to the expansion and improvement of those systems." (p. 195)

[5] *American Journal of Sociology,* Nov., 1911, p. 418.

[6] *Science,* March 10, 1922, p. 249.

[7] This refers to the catalog (*Répertoire*) of the International Institute of Bibliography.

reputation as well as to the numerous libraries that soon are to be established or are now on the point of adopting some more elaborate classification." [8]

From many expressions of librarians a few are quoted here as representative of the widely recognized need for better classification in libraries. In 1906, in a simple matter-of-fact way Mr. W. W. Bishop, then Reference Librarian of The Library of Congress, in reviewing Brown's *Subject Classification,* declared: "There is need for a popular, clear, modern, scientific classification, one made on the basis of books and of modern science, as opposed to theory and former conditions." [9] At the 1902 Conference of The American Library Association, Mr. A. H. Hopkins, then Assistant Librarian of the John Crerar Library, concluded an address on "The Organization and Administration of University Libraries" with the inspiriting words: ". . . there is one huge unsolved problem that must be faced and that is classification — not merely of books, but of things. . . . The thing to be sought is a rational plan whereby the various classifications now in use in different sciences may be unified or brought into a working relation with each other and with book classification. Here is a fruitful field. Who will enter it?" [10]

Since those opinions were published the controversy has died down, leaving the Decimal Classification and the Library of Congress Classification in possession of the field. The question was reopened in 1910 and 1912; and in 1913 and 1917 at the yearly Conferences of The American Library Association there were papers and discussions in which

[8] *Library Journal,* v. 23, pp. 607 and 609. It was for the notation rather than for the classification that the Decimal Classification was then adopted. The International Bibliographical Conference on *The Catalogue of Scientific Literature,* held in London, July, 1896, adopted the following minute, reported by Dr. Cyrus Adler, Librarian of the Smithsonian Institution, as delegate to the Conference, in *Science,* August 6, 1897, p. 195: "The Conference, being unable to accept any of the systems of classification recently proposed, remits the study of Classification to the Committee on Organization."

[9] *Library Journal,* v. 31, p. 838.

[10] *Library Journal,* v. 27, Conference, p. 16.

the present writer expressed his views and criticised the "D. C." and the "L. C.", and argued for more scientifically practical classification. But the question was not settled; and perhaps it has waited for assurance that the problem could be solved. In the meantime occasional outbursts of opinion evince an increasing dissatisfaction with the systems now predominant.

The Special Libraries Association has a standing committee on Methods, with a sub-committee on Classification. In its questionnaire sent out in 1923 this Committee asked the question: "Is there need of development of a classification in your subject?" Out of 110 answers to this question 78 were affirmative.

On the problem of classifying industrial research libraries Mr. Julian F. Smith, Technical Librarian of the B. F. Goodrich Company, read a paper, re-stating the need, before a joint session of The American Library Association's Catalog Section and the Business Librarians' Group, at the annual Conference in 1925.

Before the Catalog Section in June, 1927, Miss Grace Osgood Kelley, Supervising Cataloguer and Classifier of the John Crerar Library, said:

"It therefore seems to me that before we can talk much about competent, coöperative classification, which no one would welcome more than I, we should, first of all, as an Association, look into this matter of producing and perfecting a system that will take care of these distinctly modern books, in fields which have had an enormous and supremely important development in the last 20 to 30 years. I speak of the social, the natural, and the applied sciences."

In two recent reviews of the latest edition of Dewey's *Decimal Classification* Dr. Henry B. Van Hoesen and again Miss Kelley in the following passages imply the importance of better classification for the needs of modern studies:

"We may be pardoned, therefore, for apparently ignoring many of the well known merits and faults of the D. C. and for laying perhaps undue emphasis on certain faults which seem to us to demonstrate the need and the feasibility of a thoro reconstruction."

"There undoubtedly has been growth in our ideas as to the nature of the important part which classification is to play in rendering books available. Out of a somewhat chaotic past, there is emerging a conviction that intelligent classification will increase the general utility of the library and will open up its resources to the specialist and the scholar. The makers of an adequate system must be large-minded and far-seeing enough to grasp the system of knowledge, even in detail, and to provide for inevitable

changes. There must be a constructive method for growth, if the system is to prove a living thing." [11]

In the universities and in the "special libraries" the need for more adequate and more adaptable classification is much more pronounced and has led to many sporadic and to some concerted endeavors for betterment.

Since the more controversial papers of the preceding decade, however, interest in this problem of classification has been drawn away by compelling events. The great war supervened. Since then such large purposes as extension of services and adult education have engaged the attention of librarians. But now the problems of cataloging and classification with especial regard to coöperative services have come into the foreground.

Organization of knowledge, thought, and purpose is now progressing with marvelous rapidity and the movement has extended to nearly every field of human interest and activity. It has indeed become an age of organization, a world of organizations. In so far as knowledge is needed all thru this complex of organizations, and in so far as knowledge is embodied in books and in libraries, the classification of books in libraries with better regard for the organization of knowledge is requisite to more satisfactory library service and development. The time has indeed come for this matter to be reconsidered more earnestly than ever before, not controversially, not radically, nor on the other hand conservatively, but progressively and comprehensively, with proper regard for the past as well as for the probable future, with discernment of the practical needs and the existent conditions, of the difficulties to be overcome, of the requisite economies and the available means; and also with recognition of the scientific and educational tendencies and values. Librarians are intelligent enough to perceive the desirability of better classification and progressive enough to adopt it as essential to higher service.

[11] *Library Journal*, Dec. 15, 1928, and April, 1929.

6. PRACTICAL, SCIENTIFIC, AND EDUCATIONAL VALUES MERGE.

While simple practical classification may suffice for small public libraries, systematic and scientific classification is of pronounced value to large libraries and especially to universities; and for them it proves most practical. A classification of books consistent with the scientific and pedagogic orders has moreover educational value as the manifest organization of knowledge.

Subject classification on the shelves with relevant and expansive notation is an established principle of library economy. But literature is the main interest in most libraries. The classification of the sciences may be of value to scientists and to philosophers, but hardly to readers of literature. In classification for libraries, it is urged, there need be little regard for the order of the sciences, nor for the organization of knowledge. The interest is just practical and bookish, literary and desultory.

This view of librarians has the sympathy and respect of the writer, who was minded that way too — years ago. And it is all right for his own miscellaneous small collection of books, which are free of order yet are usually found when wanted, or soon after. And it may suffice for the sumptuous and beautifully arranged walls of books that surround the spacious room of a stately mansion, where the silent, shimmering beams of sunlight, slanting thru tinted Western windows, are the only visitants to those ever waiting, dreaming, sequestered volumes. And for the cozy village library, with its comfortable, chintz-covered wicker chairs, to which some of the girls come after school, and some of the mothers after household duties are done, and in the evening a few men, and at odd times the "gentle reader", — to this pleasant little library, and to hundreds more or less like it, the order of science, the classification of knowledge, is happily irrelevant and remote.

This is a practical view. But to be practical in this present age men must be scientific. In the household, in the building of houses and cities, in farming, in forestry, in min-

ing, in the factory, in transportation, in finance, in defence against war, against disease, against vice, against crime, even against worry, in education and even in religion, men and women should be, nay, *must* be, and despite themselves they *are* in some measure scientific and systematic, more or less dependent on the sciences of physics, chemistry, biology, physiology, psychology, sociology, and other interrelated branches of science, and in so far dependent on classification. Men of affairs have come to realize this, and business organization, of which we hear continually, is largely an organization of knowledge on a basis of science, or at least with considerable application of scientific knowledge. "Business men through engineers of different sorts, have laid hold of the new insights gained by scientific men into the hidden energies of nature, and have turned them to account. The modern mine, factory, railroad, steamship, telegraph, all of the appliances and equipment of production and transportation, express scientific knowledge." [12]

As life is inseparable from the business of life, from its industries and services, so common knowledge is continuous with scientific knowledge, which is mainly but a systematic rational development of experiential knowledge. To purpose separation of the practical and economic from the scientific and intellectual is as short sighted as youthful planning to avoid or ignore all troubles or political platforming to keep the country out of all "entangling alliances".

A library's growth and tendency cannot wholly be foreseen. It is short-sighted to hold that, because scientific classification is not now needed in a particular library or class of libraries, it will never be of value there; and it is simply bad logic to argue that, because it is of little value in small public libraries, it is unimportant even in large libraries in centers of social and educational interests. To adapt a good classification to the simple uses of a small library and to develop it while the library is growing, so that it will be adequate when

[12] John Dewey, *Reconstruction in Philosophy*, p. 41.

the library has become large and is serving the interests of scientific and studious readers, is more judicious and economical than it is on the other hand to retain the bad classification of a small library till the library has outgrown it and then to reclassify the collections when they have become a maze of complicated details and too many of the books are in use. It is wiser to adopt in the earlier stages of growth a classification that is consistent with the organization of knowledge and also with the principles of economy and progressive development. Classification, being an established principle of library economy, should thus become both scientific and educational, while at the same time practical and economical.

A university is sometimes metaphorically called a temple of learning. But the great modern university is more like a city; and its citadel is its library. This we might call a temple of knowledge, or of virtual learning. It is as comprehensive as the university. Its classification should be consistent with the organization of knowledge, with the system of the sciences, and so it should have higher educational value.[13]

[13] That a university library should be central to the halls of learning as well as architecturally dominant, so that its services could be more economically centralized, was one of the culminating themes of an article by the writer on "Departmental Libraries in Universities and Colleges" in *The Educational Review* for April, 1912. The centralization would be best justified and the economies would be most fully realized where the library's classification conforms to the Scientific organization of knowledge.

The problem of "Centralizing University Libraries", with regard to the inter-relations of studies and the several kinds of use and research, is the subject of a concise and penetrating article in *The Library Journal* of Dec. 1, 1924, by Dr. Clement W. Andrews.

Any classification of things into kinds (especially if the kinds form series, or if they successively involve each other) is a more rational way of conceiving the things than is that mere juxtaposition or separation of them as individuals in time and space which is the order of their crude perception. Any assimilation of things to terms between which such classificatory relations, . . . obtain, is a way of bringing the things into a more rational scheme.

WILLIAM JAMES, *Principles of Psychology.*

We should have a bewildering chaos of details, of forms, of things, and events, which no memory could grasp and recall unless thought could master the plurality of content by means of comparison and distinction; and could on the one hand recognize sameness and similarity, on the other, estimate degrees of difference. . . . Such a process, if completely carried out, would lead to a comprehensive system of concepts, in which the whole contents of the perceptible — of things as well as events — would be displayed in order of similarity and difference: to a classification extending over the whole sphere of perception, and finding its expression in a well established system of notation in a scientific terminology.

SIGWART'S *Logic,* translated by Helen Bosanquet.

We may progressively lay bare the order of nature and define it with the aid of the exact sciences . . . the order of nature, which must ever be regarded from two complementary points of view, as a vast assemblage of changing systems, and as a harmonious unity of changeless laws and qualities working together in the process of evolution.

LAWRENCE J. HENDERSON, *The Order of Nature.*

PART II

CLASSIFICATION, SYNTHESIS, AND THE ORDER OF NATURE

CHAPTER VI

CLASSES AND CONCEPTS.

1. WHAT A CLASS IS.

Classification applies to all things in all relations. Class is defined. Classes are comprehensive and developmental, as are concepts, the mental correlates of classes. Abstraction and generalization are distinguished. Wherein concepts are subjective and social. Classes are conceptual, relative, and adaptive. There may, however, be real classes; classes of real things are distinguished from classes of conceptual things, and of concepts. There may also be classes of qualities and of relations.

Classification as a method of mind deals with all things — with their characters and their relations. When we name a kind of tool or tree, when we define a crystal or diagnose a disease, when we judge that a certain misdeed breaks a law, when we state that a cited law applies to a particular crime, we consciously or unconsciously *class* the tool, or crystal, or disease, or crime; and in so doing we refer to some system of concepts and relations, that is, some classification. All names and definitions, all judgments and diagnoses, imply some form or aspect of classification.

But the matter is not to be dismissed so simply. There has been so much misunderstanding regarding the nature of classes and the utility of classifications that some clarification of this subject seems requisite. Detailed or exhaustive statement will, however, be unnecessary here. The treatises on logic may be consulted by any reader who may be interested to study these questions more fully. For convenience citations to authorities are given here and there in the footnotes. Our purposes will for the most part be served by brief outlines, with more precise definition and ampler discussion where these seem important.

What is a class? As was said above, we are in all think-

ing and in all judgments dealing, directly or indirectly, with classes, that is, with things regarded as like, whether they are grouped concretely in space and time or related only in thought or concept. The simplest definition of *class* is: *things related by some likeness*. This may be reduced to two words, *like things*. But these phrases are not precise. It is implied that the like things are *mentally* related, perceptually or conceptually.

The various concrete things of nature are, as we are wont to say, of different kinds, with regard to their likeness and their origin. The word kind properly implies kindred and genesis. Things of a kind in this sense are like, because like produces like. We come to know that kindred things are like not merely in special characters, or properties, or relations, or combinations of such, but in those that are *inherent and essential to their whole nature,* their organization, their functions, their very existence. Such are termed *natural kinds*. Elephants, for example, are a natural kind, and so are violets, and quartz crystals, and tornadoes. In so far as these kinds may comprise not only the objects now known but also those that henceforth may come to be known, they may be termed *natural classes*. They are of especial importance in the classifications of the natural sciences, as they are also in the economies of life. But the term *kind* is also commonly applied to things that merely resemble one another externally or functionally without especial or qualitative likeness or determinate relation, such as the different kinds of boats or fences, shoes or chisels, noises or accidents.

As the likeness of such *kinds of things* becomes conceptual and definite they become classes indeed. "Any two objects which present a close resemblance to each other will be joined and formed into the rudiment of a class, the definition of which will at first include all the apparent points of resemblance. Other objects as they come to our notice will be gradually assigned to those groups with which they present the greatest number of points of resemblance, and the definition of a class will often have to be altered in order to admit them." [1]

This applies more or less to all classes, whether they be of natural kinds or of things merely likened mentally. As our knowledge of the things becomes more exact and as the intricacies of nature are unfolded by the methods of science, the properties and relations become more specific and more complex. "Our knowledge of the properties of kind", said John Stuart Mill, "is never complete."

[1] Jevons, *Principles of Science,* v. 2, p. 365.

A class is not static or changeless, but is adaptive and developmental, even as its correlative concept is and its respective definitions should be. It may be extended to include new or newly found properties, qualities, or relations. In logical terms, the *extension, comprehension, and definition* of a class may change and develop.

A class logically comprises not only the *known* things that may be classed under its definition, but all the *existent* things that may be so classed, and even the *conceptual* and the *potential,* the future, the past, and the imaginary, according to the comprehension of its definition.

It is evident that a discussion of classes involves the correlation of classes to concepts, or class-concepts. The class-concept is the *mental correlate of the class,* the mental basis both of the general idea of the class and of its name, or names. It is developmental, the product of a process of growth. Things, for instance, trees of various kinds, are perceived to have like characters; these percepts coalesce in the mind; the general likeness becomes more and more distinct, the general character more and more definite. The characters of bark, of foliage, or branching, as apprehended in the primal perceptions and recognitions, combine in the memory to form a nucleus, or core (an analogy usually accepted even if not really true), to which subsequent perceptions cohere and subsequent recognitions are referred. This is the rudiment of the concept of tree. The less constantly recurrent or less significant characters are less and less requisite to subsequent recognitions and may be disregarded in perception and in judgment and may fade from the memory. The concept thus by *abstraction* from such particulars grows more definite. At the same time the more significant new elements cohere, or coalesce, and the concept develops in comprehension. The concept is the mental correlate of the class, as the name is the verbal correlate. This first principle, so important to the study of classification, is termed *the correlation of class to concept.*

Trees may have narrow leaves; they may have palmate leaves; they may have rough bark, or smooth bark, and so

forth. Such *specific differences* and perceptual *characteristics* may, however, prove less important than more *intrinsic properties* discovered later, such as the esculence of their fruits, the straightness of their grain, and the medicinal properties of their bark and leaves. Hence they are likely to be classified and named with regard to these, until closer analytical study reveals still more intrinsic properties and more specific characters, as well as genetic relationships and generic classes.

Economically the fruit tree is distinct from the lumber tree, and æsthetically the evergreen is distinct from the deciduous tree, and this in winter is quite different from the same tree in its summer foliage; but such empirical differences are neither generic nor specific and are sometimes indeed extrinsic. In scientific analysis the cypress, for instance, is morphologically and intrinsically distinct from the hemlock, and the yew from the eucalyptus. All, however, are generally known as trees by their size, their modes of growth, etc. There is a *general idea* to which the term *tree* in English corresponds. Of the several families there are genera, of which there are many species. There are grades of taxonomic classes comprehended by the empirical general class trees.

From particular perceptual trees, from all individual characters, from all *accidents* of place and time and circumstance, are abstracted the general characters and attributes, the essential and the significant; these essential and coherent elements coalesce to form the *concept*, or the *abstract idea*, from which arise recurrently the *generic images* of trees, or kinds of trees, and the *general idea* of tree. The abstract idea is drawn from the particular percepts and meanings; the general idea is comprehensive of, or realizable in, all particular objects or instances of the class. These two very close correlates thus differ only in connotation, the former implying *abstraction* from particulars, the latter *generalization* of the manifold various percepts, objects, or meanings. The proc-

ess of abstraction is involved in the process of concept formation. Generalization enters into the process of thinking and into the mental product of knowledge.

It has been implied here that the concept develops chiefly from the coherent relevant percepts and meanings. It may be contended, however, that the basis of the concept is not merely perceptual but more broadly experiential. This view has been presented by the philosopher, John Dewey, as the following passages may show:

"Men tried certain acts, they underwent certain sufferings and affections. Each of these in the time of its occurrence is isolated, particular — its counterpart is transient appetite and transient sensation. But memory preserves and accumulates these separate incidents. As they pile up, irregular variations get canceled, common features are selected, reinforced, and combined. Gradually a habit of action is built up, and corresponding to this habit there forms a certain generalized picture of an object or situation. We come to know or note not merely this particular which as a particular cannot strictly be known at all (for not being classed it cannot be characterized and identified) but to recognize it as man, tree, stone, leather, — an individual of a certain kind, marked by a certain universal form characteristic of a whole species of thing. Along with the development of this common-sense knowledge, there grows up a certain regularity of conduct. . . . The skill develops which is shown by the artisan, the shoemaker, the carpenter, the gymnast, the physician, who have regular ways of handling cases. This regularity signifies, of course, that the particular case is not treated as an isolated particular, but as one of a kind, which therefore demands a *kind* of action. . . . The only universality and certainty is in a region above experience, that of the rational and conceptual. As the particular was a stepping-stone to image and habit, so the latter may become a stepping-stone to conceptions and principles." [2]

A concept is subjective; it inheres in a mind. The concept of tree in one individual mind differs, or may differ, by some subjective difference from the concept of tree in other minds. As individual minds, however, have genetic and social relations to other minds of kin and community, the individual concepts of tree coalesce, by a process somewhat similar to

[2] Dewey, *Reconstruction in Philosophy* (1920) pp. 79–81. See also his *How We Think*, pp. 127–8. That some concepts are only indirectly derived from perceptual experience is also brought out by E. W. Hobson in his book, *The Domain of Natural Science*, p. 32.

concept formation in individual minds, into *social concepts* of tree, from which arise ideas of trees common and communicable to all minds of the community which are cognizant of the trees.[3] But the concept of tree in the minds of savages in the wilds of the Amazon differs from the concept of tree in the minds of scientific American foresters as considerably as a child's concept of *griffins* differs from a paleontologist's conception of *pterodactyls*. Yet from these different social concepts may be further abstracted the general *class-concept* of tree.

As individual and social class-concepts differ by subjective, cultural, or logical differences, so will the correlative classes differ, but only as the differences are definite; for classes are definite. This correlation is not impaired by the use of the same term for the slightly differing classes. In so far as these differences are subjective and conceptual, the classes so qualified, defined, and named are *conceptual and relative,* tho they may be composed of real things, and even of natural kinds.

For the diversity of things there is multiplicity of relations and therefore of classes and classifications. The relation of the thing to the class is always conceptual, is dependent on the mental act of classing the thing. In this aspect a class consisting of real things so related is conceptual; and of course classes of conceptual things are conceptual. But the class is not the class-concept, from which it differs in being of things, whole things, not parts of them, nor their qualities, properties, or relations. The concept is the residue of abstraction; the class is the totality of generalization.

The relativity of classes to minds and to relations is the specification of the comprehensive principle of the relativity of classes. According to this there may be several subjective concepts and several names for a class in its totality, e.g. reptiles, or musical instruments. For natural classes, however, there may be only one *social* concept. But for classes of

[3] *Cf.* Dunlap's *System of Psychology,* pp. 166–8, 198–200.

conceptual things, e.g. winged reptiles, or crimes, there may be any number of class-concepts relative to subjective or social differences. But in all cases the class and the correlative class-concept are definable by the same terms and have the same comprehension and extension.

The different kinds of states and governments may be defined, and under the respective definitions and distinctive terms the several states, or governments, may be classed. The special classes formed of them may objectively be regarded as real, or realized. Then of these special classes we may form a *class of classes,* or general class, termed the class of *social-political states,* which still we may regard as real.[4]

We have said that a class may comprehend not only real but conceptual things. Some classes indeed consist solely of things conceptual, ideal, or imaginary. Correlative to the classes considered in the preceding paragraph, the concepts of republic, commonwealth, community, representative government, democracy, etc. may also be likened and classified, and may then form the class of *concepts* of social-political states. Again, there is a class of classes termed *family relatives,* comprising fathers, mothers, brothers, sisters, uncles, aunts, cousins, etc., which may in one aspect be regarded as real classes, or in another aspect as conceptual classes of real things; but, aside from these two aspects, the *concepts* of the relations of motherhood, brotherhood, etc. may form a class of concepts.

There may also be concepts of *qualities* and of *relations*. The concept of yellow is drawn from coherent percepts of yellow objects, which according to the principle of correlation compose a class. As these differ in color qualitatively, we may classify them according to these qualities, and we may furthermore say that there is a class of these yellow colors or qualities. But qualitative classes have more subjective differentiation; they are, as we say, matters of taste, or valua-

[4] *Cf.* Becher, Erich, *Geisteswissenschaften und Naturwissenschaften,* pp. 96–7 and 112–15.

tion. And the concept of twins is drawn from recurrent cognizance of twin children, of which there is a correlative class; so that we may say that there is a class of twin relations. Qualities may be likened and classified, and differentiated; for instance, ripeness, mellowness, juiciness, lusciousness, etc., are a class of qualities that enhance the deliciousness of fruits.

So there are classes of concepts, of ideas, of relations, and of qualities; and there are classes of classes, whether conceptual or real. There are of course correlative concepts of all these classes, for there is a concept correlative to every class.

2. ARE CLASSES REAL OR CONCEPTUAL?

The question is complex and involves the changeful term *reality*. The three historic views are briefly stated: the realistic, affirming the reality of universals, or of concepts, the nominalistic, and the conceptualistic.

The question whether classes are real or conceptual involves the definition of the term *real,* which has had a very ambiguous career in the course of philosophy. In one view some classes are discovered in natural kinds and are real; in other views all classes are conceptual and relative to individual or to social minds. "When we . . . classify, according to their general resemblances, the objects of visible nature, . . . we feel that we are not *inventing* classes, or *constructing* grounds of division, but rather *discovering* classes by *recognizing* . . . grounds of division already existing there. We feel that we are following nature, that nature itself has differentiated class from class, roughly perhaps, but very extensively, if not universally, in every domain." [5] In this view classes are as real as the objects classed. Historically there have been three views, or doctrines, that is, they may be reduced to three classes.

The *realist* doctrine of the reality of *universals* may be stated simply thus: not only is the tree real and the forest

[5] This is abstracted from a paragraph in Coffey's *Science of Logic,* v. 1, p. 129.

of trees real, but that reality extends to all trees, wherever they may be, present, distant, past, and future; all trees have a common nature in the characters and properties that distinguish them as trees; and it is this "essence" which is conceived, defined, and named, "something that is conceived as common to all the members of a class." It is this "universal" that is real. The same may be said of gold, and of goodness, the essence of good things. All particular masses, particles, and objects of gold constitute the class of golden things, the essence of which is universal and real.[6] The extreme doctrine handed down by Plato held that the universal essence of a class exists antecedent to the individual things (which are regarded as its realizations or embodiments), and that *this essence is the reality*. Akin to that is the modern doctrine of the reality of general ideas independent of physical realities. This issues in the confusion of the real and the ideal in certain schools of idealistic philosophy.[7]

The *nominalists* asserted that it is the *name,* the term, that is defined and denotes the class, and that the name is common to the things classed by it. Among moderns John Stuart Mill made this doctrine respectable, tho he was not always consistent in it, for sometimes he defined the class as determined by, or coexistent with, the name, and sometimes he defined the class as determined by its characters. It is too much like putting the cart before the horse to say that a name is that which solely determines a class, or is the only thing common to all the members of a class. It may change while the class changes neither in definition nor in extension. There may be many names for a class. Each language, dialect, and slang may have its different name for the same class.[8]

[6] Coffey, *Op. cit.,* v. 1, p. 9; also Joseph, *Introduction to Logic,* 2nd ed., 1916, p. 32.

[7] For instance in Green's *Prolegomena to Ethics,* pp. 25–9.

[8] ". . . if some other mode of communication were natural to man instead of the language of sounds, the same logical associations would find in it a corresponding expression though of a different kind." Lotze, *Logic,* Bosanquet tr., v. 1, p. 19.

The *conceptualists* have held that there is no reality in a common or universal nature in a class of things, and that it is neither such a logical universal nor the class-name, but just the *concept,* or general idea, of the thing that is thought of, defined, and named.[9] This third doctrine has predominated in modern thought, tho in several divergent theories, some of which tend to return to the olden realism and some of which venture into *new realism.* The whole question is confused in the persistent problem of the subject-object relation.

Sigwart, whose work on logic was published in 1878, avoided the term *class,* using the term *concept* consistently thruout. He made a point, however, of distinguishing between the generic concept and the genus in its concrete sense as the sum-total of all the things that fall under the generic concept, — for instance, between the generic concept "human being" and the "human race or genus." (Mrs. Bosanquet's translation, v. 1, p. 272).

A very clear brief statement of the three doctrines is given by the English writer, W. R. Boyce Gibson: "The *realists* have maintained that it is *things* that we define; the conceptualists, that we define *meanings;* the nominalists, that we define *words* and *names.* The controversy hinged on the meaning of the 'universal'. The realists held that things had, in all those relations in which they resembled each other, a common or universal nature, and that in defining this *common* nature, we were defining what was at least as genuine and indispensable a constituent of reality as was the individual nature of objects. The conceptualists held that the universal element existed, not in the objects themselves, but only in the thought which conceived them; the true universal was the concept. Finally, the nominalists held that things called by the same name had nothing in common but the name." [10]

3. A SCIENTIFIC AND CRITICAL REALISM STATED.

The doctrines of "critical realism" are mentioned. The subject-object relation is briefly stated. Realism, scientific and critical, is affirmed. Wherein classes are real, and again wherein conceptual.

In the recent philosophical movement that produced *The Essays in Critical Realism,* published in 1920, it is maintained by the several authors that neither the existent physi-

[9] This may be compared with statements by Coffey (*Op cit.,* p. 10) and by Joseph (*Op. cit.,* p. 32).

[10] *The Problem of Logic,* London, 1908, p. 24.

cal object nor the subjective or conceptual correlate is the object of perception, but a mediate correlative *datum,* which consists of the "essence" either of the physical object or of the conceptual correlate or of both, and is in some respects a logical universal.[11]

If subjective and social concepts and changing names did not depend on existent physical realities, our experience and knowledge would be only of mental things; the world would be wholly mental, or ideal. The conceptualistic view comports with the idealistic philosophy. But the world about us, the things that affect our senses, are convincingly real in the coherent experience of ourselves and of those with whom we converse. In our reflective moods we may doubt this reality, but in our sanest intelligence we sustain its verity. Logical proof for this belief may be lacking, but the belief is as rational as its refutation, and it survives the skeptical denials of the reality of existence.

Let us consider briefly the subject-object, or knowledge, relation, which is involved in the foregoing questions. Objects appear to subjects, who consistently describe them in terms of common experiences. We say that we perceive the objects, and that they are perceptual objects, existent independent of ourselves and perceptual to other subjects also. We distinguish, cognitively or intuitively, between the subjective, the perceiving, the perceptive, as within our minds, or *mental,* — and, opposed to these, the objective, the perceived, the perceptual, as external to our minds, or *physical,* but in some way correlated to the mental. Mental are the perceptions, the *percepts* that compose them, the meanings and the memories of them; these pertain to the subject aspect of the correlation, and enter into the *experience* of the subject. Percepts and meanings are assimilated into *concepts.*

[11] We lack space for quotations to epitomize the interesting doctrines of these *Essays,* but a few citations may serve: Professor Pratt's statement, most in keeping with our thought, appears on p. 110. Santayana defines his view on p. 168. Sellars distinguishes "datum" from physical object on p. 213, and from object of perception on p. 210. Strong's distinctions appear on pp. 223, 225, 231–2.

Concepts and organized meanings are synthesized and organized into *knowledge*. But correlative to these mental "contents", *data, phenomena,* or whatever they may be called (even "perceptual objects"), there are the *existent,* or physical, objects, or *things,* of which the physical actions and properties external to and independent of subjects "cause" the effects, sensations, and responses in the subjects. The recurrence and coherence of our experiences of objects and the consistency of our experiences with those of other subjects produce our belief, or faith, in the existence and the persistence of the objects, and these are the objective realities of realism. *Reality is existence verified, or verifiable, by coherent experience.* Knowledge is correlative to reality, tho imperfectly, but is progressively veritable. As error and falsity are eliminated, the correlation becomes more true. Truth is the relative quality of knowledge veritably correlated to reality. Subjects, percepts, concepts, knowledge, realities, existent objects, — these are the progressive, correlative terms in the subject-object relation. The reality of objects in real relations constitutes the reality of existent systems, and upon this depends the conceptual verity of the realistic universe and the intellectual faith of realism.

This is the view of scientific, or naturalistic, realism, which is here affirmed. This view should not be mistaken for what is by philosophers disparaged as "crude realism" or "naïve naturalism"; for it is not naïve but scientific, not crude but critical.

"Critical realism accepts physical realism. Like common sense, it holds to the belief that there are physical things; and, like enlightened common sense, its idea of the physical world is moulded by the conclusions of science. It is a criticism of *naïve* realism, and an attempt to free it from its prepossession that knowledge is, or can be, an intuition of the physical thing itself." [12]

"The critical realist . . . does maintain that by far the most reasonable construction of the facts of experience points to the three following conclusions: (1) that there are other minds or centers of experience beside his own, and that there are also existent

[12] Sellars, *Op. cit.,* p. 189.

physical entities, independent of the minds that know them, but which stand in some sort of causal relation to these minds — in short, the general realistic view; (2) that we human beings are so coördinated with the rest of nature that when our psycho-physical organisms are acting normally our percepts refer to and (in a pragmatic and functional sense) correspond with existent entities which are not part of our mental content; and (3) that we can make these various independent entities the objects of our thought, and by reasoning upon our experiences can come to conclusions about them which are true and which deserve the name of knowledge." [13]

Of this subject-object, or knowledge, relation there are dual aspects; and the correlation between subject and object is so intrinsic that thought unwittingly slips from the one to the other correlate and as naïvely glides back again, often unperceived. In brief, the one correlate is mistaken for the other.[14] Hence arise the many contradictions and confusions that impair philosophic thought. When this epistemological quibble involves logical legerdemain, it behooves intellectual sincerity to open the windows of philosophy and let in the sunlight of science.

A class is *real* in so far as the things classed in it are real and the relations between them are real. This reality may, within our definition of the term, be extended to comprise things that would potentially come into the class. So we may say that some classes are real. But the relations of the things to each other may not be real, may be conceptual or arbitrary. Then, tho the things be real, the classes are conceptual. Moreover, the things may be classed now with regard to one character, concept, or relation, and again with regard to some other. For the diversity of things there is multiplicity of relations and therefore of classes and classifications. That is, the classes may be relative or selective. In view of all these considerations it seems valid to conclude

[13] Pratt, *Op. cit.*, p. 105.

[14] Further discussion of this difficulty is not requisite here. The writer's views on these matters may be consulted, by anyone interested, in an article "On the Subject-object Relation" in *The Philosophical Review*, v. 26, pp. 395–408.

that some classes are in certain aspects real, whereas in other aspects they are conceptual.

4. GROUPS DISTINGUISHED FROM CLASSES.

Group is distinguished from class: a group is distinct, perceptual, and usually concrete and real, and is complete, but is not, like the class, definite. There may, however, be groups of conceptual entities. Groups are often miscalled classes, and classes miscalled groups.

Real things likened and classed may be physically grouped in space and time, as when books classified in one room are brought together in another room and there shelved in order with groups already present in the several classes. A *group* is a certain number of things that are together in space and time, a composite of things that may be like or unlike, at any instant composed of concrete things in some configuration, but not restricted to those things, or that number of things, or any particular configuration, nor restricted as to class; that is, its components may come or go or change and may be of many classes.[15] Two mothers wheeling baby-carriages meet two others with a little boy and a little girl; they stop and form a group while they talk. A dog trots up and sits beside — is added to the group. A janitress sweeping the steps beyond and overhearing the gossip may be included by the observer; and his interest in the whole situation may extend to a delivery wagon at the curb, whose driver jumps down and stops to chat with the janitress. Objectively the whole might be grouped in a photograph. Tho groups are usually real, concrete, and perceptual, like the above, or like a group of "still life" for an artist, there may also be groups of conceptual or mental entities. In mathematics the term *group* is not restricted to symbols; and in discourse we speak

[15] Baldwin's *Dictionary of Philosophy* defines *group* more briefly in generalized language as follows: "A plurality of individuals apprehended or treated together, yet with recognition of their individuality. . . . The recognition of likeness in the individuals is not necessary to the group, as it is to the general; nor is there of necessity any abstraction from their qualities."

The relations of the several kinds of social, community, and political groups to group consciousness are outlined very clearly in Dunlap's *Social Psychology,* Chapter V.

of a group of ideas, or activities, or events. However composed, a group at any instant is distinct, tho not definite, and is complete in itself; and herein it differs essentially from a class, which is definite, tho not necessarily distinct, and which as a totality may be partly unrealized, comprising like things not present. It is seldom that the group includes the whole class, tho it may, provided that the definition of the class specifies or limits the time, place, series, or other existential relations.

Yet a group is often miscalled a class, as when we speak of children in a school-room as a class, tho some pupils that are, or should be, classed with them may not be present. And librarians speak of a group of books on the shelf as a class, tho some are being used elsewhere and others are likely to be classed with them in the near future.

5. THE DEFINITION OF CLASS.

The amplified definition is briefly discussed. The class is relative and developmental with regard to characters, but it comprises a totality of things, as wholes, not merely their essences or properties.

We may now amplify the definition of *class* given in the first section of this chapter. *A class consists of all the things that are, or may be, related by likeness in the essential, significant, and selective characters, properties, and relations, by which it is defined.* The extension of a class comprises *all* the things, real or conceptual, known or knowable, existent or past or future, that are, or may be, comprehended by its definition, which connotes the essential characteristics, properties, and relations of the class. The likeness of the things classed may inhere in a single significant or important character, property, or relation, or in any combination of these, or in the whole nature, or "essence", of the thing; that is, it may be partial, or relational, or essential, or complete; it may be characteristic or attributive, selective, arbitrary, or conventional; broadly speaking it may be intrinsic or extrinsic; and it may be qualitative or quantitative

The class is the totality of the things defined; it is *all* the *things* in their entirety, as wholes, not merely their properties, qualities, or "essences", tho it is by these that the things are likened and the class is defined. The class may be logically distinguished from the properties common to the things classed in it, from their essential qualities, and from any combination of these (connotation, intensive definition, or convential intension, as variously termed by logicians); it should also be distinguished from the total characters, or attributes common to all the things classed (comprehension, or objective intension.).[16] The class is not like a container, tho it may be regarded in that analogy. Nor is the class static and in all senses complete; it is in a sense incomplete and developmental in its extension, comprehension, and definition. In another sense, however, the class is *potentially* complete, comprising not only existent but *all* past and future or possible things that may be defined by its definition and named by its name.

[16] See Keynes, *Studies in Formal Logic*, 4th ed., pp. 23–4 and 31; also Coffey, *Op. cit.*, v. 1, pp. 49–52.

CHAPTER VII

DEFINITION, NAMES, AND LOGICAL DIVISION.

1. DEFINITION IN RELATION TO CLASSING.

Classes may be distinguished by their significant characters or by their typical characteristics; they are defined by their generic and their specific differences. Definition has its logical aspect and its linguistic aspect. Genera and species in successive subordinations compose a gradation of classes from the most generic to the most specific. Definitions are applied in classing things, and they should be adaptable to changes in characters and properties. Several kinds of definition are distinguished, also description and analysis. The relation of definition to class is exemplified.

In the preceding chapter we distinguished the *class* first from its mental correlate, the *class-concept,* then from its verbal correlate, its name, or names, and finally from its more explicit linguistic correlate, its *definition in generic and specific terms.* We have now to consider more adequately these two related linguistic correlates.

In classing things the mind regards or selects those characters, properties, and relations which seem at the time especially relevant, significant, or important. These are the *characteristics* of the class. As perception is selective of objective elements, as the concept-process is selective of perceptual elements, so the classing process is selective of elements both perceptual and conceptual.

Sometimes the properties are so linked together, or correlated,[1] that to designate one or two characters suffices to distinguish the class. Thus cloven hoofs and quadruple stomachs, or cud-chewing, characterize the ruminant animals. The metal mercury, that is, the class of all masses and par-

[1] One must distinguish between this use of the term *correlate* in an active sense meaning to combine or link two or more properties, relations, causes, or terms, and the use above in a substantive sense for those things, relations, or terms, that correspond to or complement one another, as, for instance, *class* and *name.*

ticles of mercury, is sufficiently specified by the characteristic silvery metallic luster and the property of being fluid at ordinary temperatures. "What is black and white and red all over?" So ran a conundrum of ambiguous terms in our grandmother's days, anticipating both a simplified spelling and the ubiquity of the modern newspaper, which those three terms would suggestively define to any wit.

By a single prominent *typical* character we often recognize an object or class a *specimen*. Other typical class-characters may at the same time be cognized more dimly. On the other hand classing a thing may require careful examination and comparison by many minute external characters, or may involve *dissection, analysis,* or testing of several internal properties or relations.

Definition is intermediate between mere recognition of the characteristic or typical and *description* or analysis of the whole nature of the thing, or of the class to which it is ascribed. By definition both the *generic* character, or *essence,* and also the *specific differences* and even the relations are made first logically distinct and then explicit in language. *Logically* definition is a process in which the comprehension of the concept, or class, is rendered more distinct by development about a dominant, essential, or generic character, and by the subordination or even submersion of unessential or accidental details. *Linguistically* definition is explicit statement in terms that connote the characteristics of the class, showing implicitly the comprehension of the class-concept, and sometimes its extension. Properties and characteristics that are unessential (propria) or individual (in logical terminology, *accidental*) are not included in the definition, tho some of the *propria* may enter the concept or meaning and even be relevant to the defining interest.[2]

In the infinite diversity of nature manifold differences throng upon the attentive mind. Things like in general character are found to differ in special characteristics, marks, qualities, or relations. Natural kinds and common things of a kind are thus as a matter of course progressively divided and subdivided, whether in scientific or in economic interests. Each larger class becomes the genus that includes the seve-

[2] See Gibson, *The Problem of Logic,* pp. 25–6; also Joseph, *Introduction to Logic,* p. 75; also Barry, *The Scientific Habit of Thought,* pp. 128–31.

ral species, and these in turn become genera inclusive of subordinate species, until the series is reduced to the lowest species by the most *specific difference* that is discernible or significant.

The term *species,* as long used in the classificatory natural sciences, no longer connotes a genetic constancy to specific differences, but admits of some adaptation and variation. Some individuals indeed are found to be of doubtful status; they do not come clearly within the definitions and they may be classed under the one species or the other.

Definitions should be *adaptable* as classes are developmental and adaptable to new knowledge of the nature, characters, and properties of their contents.[3] It is often requisite to make new definitions and to adopt new names. A new set of phenomena have necessitated extension of the class *crystal* to include the sub-class *liquid crystal,* and the definition must likewise be made more extensive. Thus the definition should be made to fit the class, or the class-concept, not the class to fit the definition; but, when a class has been well defined, then any instances that occur may be classed as they conform to the definition.

Definitions are *applied* in classing things, which are compared with the definition to determine whether they have the generic characters and the specific properties of the class. Or the individual may be compared directly with a *type* of the class — a specimen exhibiting the characteristics very distinctly — if one be available. But this latter method may in cases be less accurate.[4]

Scientific definition is more comprehensive than the briefer logical definition, or the *working* definition, in some logics termed *diagnostic* definition. It is sometimes amplified for causal or developmental relations of importance; sometimes it approaches to *comprehensive* definition, and sometimes to *analytical* definition.

[3] *Cf.* Chapter VI, pp. 120–3.
[4] *Cf.* Jevons, *Op. cit.,* pp. 411–13.

"It involves careful observation, comparison, and analysis of the things observed, abstraction of the mind from their differences and generalization, besides the power of distinguishing primary from derivative properties." [5]

Gibson states this as follows: "Thus the relatively simple and schematic requirements of formal definition are quite inadequate for the purposes of Science: the distinction between formal and scientific definition is inevitable; . . . .

"To have defined a term or concept scientifically is to have analyzed its relations to other concepts characteristic of the same scientific system, and to have then synthesized these relations in the simplest and most relevant way possible." [6]

Scientific definition is distinguished from *denotative*, from *expository*, and from *descriptive* definition in Professor John Dewey's *How We Think* (pp. 131–4).

A class may be defined differently, according to the point of view: thus *circle* may be defined in terms of *points*, as the class of points equidistant from a given point and in one plane; or *circle* may be defined in terms of *motion*, or *origin*, as the line generated by a point moving in a plane at a constant distance from a given point in the plane.

"But when we are studying objects not for any special practical end, but for the sake of extending our knowledge of the whole of their properties and relations, we must consider as the most important attributes those which contribute most, either by themselves or by their effects, to render the things like one another, and unlike other things; which give to the class composed of them the most marked individuality; which fill, as it were, the largest space in their existence, and would most impress the attention of a spectator who knew all their properties but was not specially interested in any." [7]

Description, whether in science, in history, or in story, is much more complete in setting forth characters, particulars, accidents, and details, than are definition and analysis; and it may be not only analytic but synthetic. It may be a description of the parts, or members, in detail together with a survey and an explanation of the whole in its general aspects and relations, including various definitions. But to discuss

[5] Welton's *Logic*, v. 1, p. 108.
[6] *Op. cit.*, pp. 30–1.
[7] Mill, *Logic*, Book IV, Chap. VII, end of § 2.

description further in relation to the organization of knowledge would be aside from our purpose. It is mentioned here only as the most detailed of the series of linguistic correlates of classes or concepts: names, terms, definitions, analyses, descriptions.

The relation of the definition and the name to the class may be exemplified as follows. Chisels are definable as *hand tools cutting at one end with a bevel edge.* Here four essential characters are connoted. Wood-working chisels have the bevel on one side and are sharpened on that side. *Cold chisels* for cutting metal objects of certain kinds have *both sides* beveled. Certain chisels for paring wood have, besides the cutting bevel, two edges beveled all along on the same side; they are the sub-class *beveled paring chisels.* As a chisel-handle pierced by a *tang* is likely to split from being struck with hammer or mallet, the handles are set in sockets in *socket chisels.* *Mortise chisels* have such sockets but are further strengthened against breaking by their increasing thickness up to the handle, and this makes them work straight in the mortise. Each of these species, or sub-classes, may be defined by its difference and named by its characteristic.

2. NAMES AND TERMINOLOGY.

Names composed of several terms may approach to definitions. Terms have definite meanings and usage. Scientific terms are mostly systematic. A nomenclature is a system of names, some consisting of several terms. A class may have many names.

Names and terms are, we have said, the verbal correlates of the classes they denote, briefer than definitions, more definite than signs or symbols. They are used, however, to designate, not to define. What they denote, or connote, the definition makes more explicit. Yet sometimes a thing may not have a short name in common usage, and the group of terms that designate it may be more like a definition, e.g. *the fore gaff-topsail sheet of a schooner yacht.* The bands of chased gold that encircle the barrel of my fountain-pen have

no short distinctive name in common usage, tho they may have in the manufacture. The *stationary wave* in a rapid brook just below a large stone nearly submerged can be brought to mind only by successive phrases of descriptive terms such as are employed in this sentence.

The *terminology* of a science, art, industry, trade, or profession is a system of terms to which more or less definite and conventional meanings or denotations have become attached for the current usage of the persons interested. Scientific terms, especially those of morphology and of chemistry, are more or less systematic in connoting the relations of species to genera, and of chemical combinations, e.g. *Viola blanda,* the white violet, and the group of terms: sulfuric, sulfurous, sulfate, sulfite, and sulfuret.

Nomenclature is a system of names for a system of classes, or classification. Some of these names may consist of two or more terms; some may even employ descriptive terminology to a certain degree of specification.[8]

Definitions are, or should be, adaptable; but names are changeable, even without change in the definitions. In other words, the correlation between name and definition is not relatively fixed like that of definition to class or concept, but is temporary or conditional. A class is definite, its definition adaptable, its name multiple; it may have many names in the several languages, in any of which it may have several synonyms.

3. LOGICAL DIVISION.

Definition by difference effects logical division, successively more and more specific. Dichotomy, or bifurcate division, strictly gives negative *residua* of little value in classification, but useful in residual classes, and also in diagnosis. Definition renders knowledge and judgment more distinct.

Definition of a species by its difference from the genus, or from other species of the genus, effects a *division* of the spe-

[8] "A descriptive terminology must be carefully distinguished from a nomenclature. The nomenclature of any classification consists of the names for the groups or kinds which the classification systematizes; the words by which these groups are characterized constitute the terminology." — Gibson, *Op. cit.,* p. 67. *Cf.* Coffey, *Op. cit.,* pp. 131–3.

cies from the genus, or a further division of the genus into its several species. *Logical division* partitions the extension of classes where definition limits the comprehension of sub-classes or the *intention* of their terms. We should not, however, be misled by the term *division* to mistake this logical process for a physical division into component parts; for species are not *parts* of a genus; they are sub-classes, or differentiations. Logically division continues *differentiation* beyond where definition ceases to specify, and it does this by applying successive distinctions.[9]

Thus, the garden plants commonly called beans may be defined as bearing legumes, or pods that are edible, produced from *papilionaceous* flowers, and productive of highly nutritious seeds containing much protein and fat; but by *division* from the order *leguminosæ* is differentiated the family *fabaceæ* (*papilionaceæ*), which has the corolla wing-like and with a keel, and which comprises the peas, lentils, broad-beans (*faba*), and a multiplicity of less familiar kin; and from the genera of this family is distinguished that of the beans (*phaseolus*), common in America. The definition may continue with the division of these into species of *kidney, Lima, Sieva,* and *string* beans, and with the differentiation of the string beans into the varieties of *pole* and *bush, shell,* and *snap;* and furthermore those with succulent pods may be either round-podded or flat, and those round-podded may be crease-backed; but any one of these divisions may be further differentiated into the several varieties and *strains* of *green-podded* and *wax* and stringless string beans that are so grandiloquently described in the glowing pages of the incomparable catalogs of commercial seedsmen.

For such minute division of species definitions might be framed that would epitomize the more important successive differences, but usually names are employed, less often attributive than arbitrary or personal; — the variety or kind is named after some person or place. Among such names the amateur gardener may indeed be at a loss to choose. His produce may turn out very different from what he expected. Such names, tho particular or special, are neither specific nor (as regards characteristics) definite.

Dichotomy is the term, derived from the Greek logicians, for the *bifurcate* division of a genus by a single significant difference into a species and a residuum, which may or may not be disregarded in further division. "Of course, if a

[9] *Cf.* Gibson, *Op. cit.*, p. 41.

genus falls naturally into two species, it ought to be divided into two; as number is divided into odd and even, and line into straight and curved; but this is not mere dichotomy; for it is not the same to divide number into odd and even as to divide it into odd and not odd." [10]

In logic dichotomy is a valid method and is implied, as Jevons said, in all classing, especially in *diagnosing,* or classing things in a system of classes, as is done by the aid of a botanical key to the families and genera of plants. But otherwise in scientific and in purposive, or practical, classification dichotomy proves uneconomical, tho sometimes it is serviceable in a *residual* class such as the *minor arts* or the non-Aryan languages. We shall come back to it when we come to discuss the time-worn terms *subordination* and *co-ordination* in the classification of knowledge.

The correlative logical processes of classing and defining render more distinct our knowledge of the things of nature and of life in their manifold relations; and thus our use of those that are useful is much facilitated and our values of those that are enjoyable are in many ways enhanced. This side of our mental fabric largely consists in recognizing, distinguishing, and choosing with regard to values and tastes, and in exercising judgment as to proper uses. In brief, we thus attain to increasing knowledge, ability, and refinement. But intellectually we need knowledge not merely of things but of their relations; we need, as we say, *to know more about the things;* and economically we need to control certain of the relations, at least to some degree, in productive industries, in protective measures; and we need, with higher spiritual need, a less confused and more intelligent survey of the complex world of entities and intricate relations in which we dwell.

[10] Joseph, *Op. cit.,* p. 125. The three sentences quoted below are from his preceding page. The examples of dichotomies he criticizes there show how unreal or inapplicable the *residua* may be in some cases. ". . . a forest is not a form of not making a farm. . . . Neither again is grazing a particular way of not plowing land, nor growing tree-fruit a particular way of not growing bush-fruit on it.

". . . in a division which attempts to classify by dichotomy half the differentiæ are useless for the development of the generic notion."

CHAPTER VIII

CLASSIFICATION.

1. SOME RELEVANT DISTINCTIONS.

Ambiguities of English derivatives ending in *ion* are considered. The terms *class*, *classify*, and *classification* are defined. Certain definitions in dictionaries are inadequate.

A series or system of classes arranged in some order according to some principle or conception, purpose or interest, is termed a *classification*. This term, like other English derivatives ending in *ion*, is ambiguously used both in the predicative and in the substantive sense, now for the action and now for the act, sometimes for the process and sometimes for the product.[1] It seems desirable, however, to distinguish these two meanings and to employ the term *classification* distinctively in its substantive sense, while the term *classify* and its participle *classifying* may well serve all uses in the active sense. We thus should have a series of definitions such as follows, proceeding from that of *class* as substantive.[2]

(1) The verb *to class* denotes likening, referring, or assigning a thing to some class, or several things to their respective classes, as may be requisite or relevent to interests involved. This verb is used not only transitively, but sometimes intransitively. Thus it may be said that olive oil *classes* as a luxury.

[1] Similar ambiguity inheres, for instance, in the terms: action, production, transition, definition, division, perception, etc. But some others are used only one way, e.g. position and discretion. Certain words ending in the suffix *ment* are likewise ambiguous, e.g. arrangement and argument. There is an important distinction between the act of arranging a group of books and the resulting arrangement regarded objectively; but the distinction between an argument as a verbal fracas and its mental product boiled down to a sequence of propositions is more elusive.

[2] Our definition of *class*, to which the reader may wish to revert, appears in its simple form in Chapter VI, § 1, and in comprehensive terms at the beginning of the fifth section of that chapter.

(2) The verb *classify* means primarily to make, or *conceive,* a class, or classes, from a plurality of things, and secondarily to arrange classes in some order or to relate them in some system according to some principle or conception, purpose or interest. In the primary sense, to classify implies that certain things are likened to form the nucleus of a class, and furthermore that other things so likened subsequently are referred to, or assigned to, the class. In the secondary sense, to classify implies both that things are classed and that classes are formed or conceived; but it adds moreover that the classes are arranged or systemized. *Classifying,* as participle and as verbal noun, accordingly serves both in the primary and in the secondary sense. It is in the secondary sense especially, for the process of arranging classes, that the term *classification* is so often ambiguously used. These three processes, classing, forming classes, and arranging classes, are so implicated that it is not easy to separate them in thought or in terminology; yet we propose here that this should be done as conducive to precision in this study. There is an important distinction between assigning a thing, or things, to some class or classes, and arranging classes in some order or system. When naturalists or librarians or business men speak of *classifying* specimens or books or items of accounts, they usually mean *classing* them, in the strict sense distinguished above, tho this may sometimes also involve arranging and rearranging the classes.

(3) A classification is a series or system of classes arranged in some order according to some principle or conception, purpose or interest, or some combination of such. The term is applied to the arrangement either of the class-names, or of the things, real or conceptual, that are so classified. The term *classification* is also by derivation and use the name for the classifying or arranging of classes, or things, as a process or method.

Mill in his *Logic* applied the term *classification* first to the classing, or naming, of things, secondly to the "arrangement and distri-

bution of classes"; but he carefully and explicitly distinguished between the two "kinds" of classification.[3]

Baldwin's *Dictionary of Philosophy* defines classification as "the process of arranging the objects of some province of experience into kinds or groups, characterized by the possession of common marks."

In *Encyclopædia Britannica* classification is defined as "a logical process common to all the special sciences and to knowledge in general, consisting in the collection under a common name of a number of objects which are alike in one or more respects. The process consists in observing the objects and abstracting from their various qualities that characteristic which they have in common."

These are good definitions but inadequate, and they disregard the substantive uses of the term *classification,* which are sufficiently distinct and which are no less commonly used. We are all the time reading and talking of the classsifications of science, of philosophy, of libraries, of freight, of tariffs, of diseases, of laws, etc., meaning not the *processes* of classifying the things, but the arrangements, the schedules, the codes, the systems, or the order of any of these, in a word, the *products* of the processes of classifying. But these are the products, someone will interpose, of *classification,* and the noun is useful as the name of the *process,* or method. So it is, and such use should not be disallowed. It is more useful, however, as the name of the product. Otherwise to distinguish this we should have to use some phrase composed of three words, thus, *series of classes, system of classification,* or *schedule of classification;* but all of these terms may have specific connotations. Nearly all the meanings covered by the definitions just quoted may be rendered by the terms *classing* and *classifying,* to which indeed they more precisely fit. The need for a distinctive term for the products of classifying must be perceived by those who carefully consider the subject of classification. The dictionaries recognize these distinctions; but their function is to record the customary uses rather than to indicate distinctive usage, and they often fail to clear up the ambiguities and inconsistencies of the English language.

2. CLASSIFYING AS A METHOD OF MIND.

Classifying is a method essential to the organization of knowledge. Its intellectual value is expressed by James, Royce, Jevons, Mill, Ostwald, and Dewey. Certain psychological and philosophical considerations follow. Purposive classifying is distinguished, and general from special purpose.

The attempt in the two preceding chapters to clear our minds of current confusions regarding the nature of classes, concepts, groups, realities, names, terms, and definitions, has

[3] Book IV, Chapter VII, § 1.

led us into deep waters, from which the reader may now emerge weary of logic. Our subject rests, however, not only on logical but also on psychological grounds. We should be merely skimming the surface, if we did not consider what underlies it. Classifying is a method of mind. Certain psychological considerations are therefore both relevant and requisite to the proper treatment of the subject.

The forming of classes, the classing and classifying of things, and the arranging of classes in classifications are processes that are intrinsic to all knowing and all thinking, and to the composite processes termed *mental synthesis, synthesis of knowledge,* and *organization of knowledge.* In these processes classification is the less spontaneous, the more rational and methodical component; it is not merely a process of unconscious mental synthesis; it is a conscious method of mind, dealing with all things in all relations. Classifications are the rational and systematic products of that method.

This rational and methodical development attains in logic and in the methodology of science and philosophy to a *science of order,*[4] which is fundamental not only to the mathematical treatment of problems, but to the precision requisite to exact science and to philosophy. "Science can extend only so far as the power of accurate classification extends. If we cannot detect resemblances, . . . we cannot have that generalized knowledge which constitutes science; . . . ." [5]

"Classification, thus regarded, is a contrivance for the best possible ordering of the ideas of objects in our minds; for causing the ideas to accompany or succeed one another in such a way as shall give us the greatest command over our knowledge already acquired, and lead most directly to the acquisition of more. The general

[4] "A sketch of Methodology has shown, in the case of the Comparative, and the Statistical Methods, and of the Method which unites Observation and Theory, that all these methods use and depend upon the general concept of the *Orderly Array* of objects of thought, with its subordinate concepts of *Series,* of the *Correlation of Series,* and of special *Order-Systems,* such as that of the Quantities. All these concepts are essential to the understanding of the methods that thought employs in dealing with its objects. And thus a general reveiw of Methodology leads to the problems of the Science of Order." — Josiah Royce in the *Encyclopædia of Philosophy,* v. 1, p. 92.

[5] Jevons. *Principles of Science,* v. 2, p. 421.

problem of Classification, in reference to these purposes, may be stated as follows: To provide that things shall be thought of in such groups, and those groups in such an order, as will best conduce to the remembrance and to the ascertainment of their laws." [6]

This method is brought within the purview of purposive classification; and general purpose is distinguished from special purpose. The following sentences are especially relevant to the main argument of this book:

"The *general* aim of all classification is, of course, to give us clear ideas, definite, well-ordered knowledge, control over facts, increase of power in retaining and communicating our knowledge about them. But every single department of facts will be found to yield on investigation several widely distinct and very *special* kinds of knowledge, in addition to what may be described as general knowledge of that department. And hence we may have one or other of two possible purposes in approaching any sphere of classifiable data: we may wish to classify the contents of the sphere in question with a view to obtaining some *special kind* of knowledge about them, with this *special* object in view; or, without any such particular preoccupation, we may approach it with a view to acquiring *general* knowledge, general information about them. The former process is called *Classification for a Special Purpose,* the latter, *Classification for General Purposes.*" [7]

This aspect of purposive classification will be treated more especially in a subsequent chapter under the caption of the *principle of maximal efficiency.* But over and above this value and utility of classification are its values in the extension and clarification of our intellectual comprehension of otherwise chaotic materials and phenomena.

A general and comprehensive classification of the universe of realities and relations is most difficult to achieve. To that purpose, however, the various special classifications that serve in the special sciences and the economies of life largely contribute. That this process is operative thruout the fields of human activity is implicit in these sentences of John Dewey:

"Organization is no more merely nominal or mental in any art, including the art of inquiry, than it is in a department store or railway system. The necessity of execution supplies objective criteria. Things have to be sorted out and arranged so that their

[6] Mill, *Logic,* Book IV, Chapter VII, § 1.
[7] Coffey's *Science of Logic,* v. 1, p. 123.

grouping will promote successful action for ends. Convenience, economy and efficiency are the bases of classification, but these things are not restricted to verbal communication with others nor to inner consciousness; they concern objective action. They must take effect in the world. . . . There must not only be streets, but the streets must be laid out with reference to facilitating passage from any one to any other. Classification transforms a wilderness of by-ways in experience into a well-ordered system of roads, promoting transportation and communication in inquiry." [8]

3. THE LIMITATIONS AND THE RELATIVITY OF CLASSIFICATION.

Some things can not be classified definitely. It is so with some qualities. The relativity of classifications is stated with reference to the relativity of classes. Classification is distinguished from system. Classifications are conceptual, but they may be realized or objectified.

There are fields of knowledge and of thought, however, where definite classes are not formed and are not feasible, especially in dealing with qualities and quantities. Of course we may for convenience definitely class quantities or qualities and then classify them relatively to standards of measure or of taste. The term *orange* may be applied to a series of tones of yellow more or less like the various colors of that kind of fruit. The term *tall* may be applied generally to men more than seventy inches in height. But our pleasures and pains — it is hardly feasible to classify these, or the timbres of bells, or the various composites of clays. Yet to some extent we do attempt in our ordinary unprecise ways to class and to classify some of these very things, these colors and sounds and pains.

Another kind of limitation arises from the relations of selective perception to interest, together with the uncertainty of discrimination, as affecting the relativity of classes. The nature of this limitation may be apprehended in these sentences from Joseph's *Logic:*

"Now we do not in experience find that things fall into kinds which fit into any perfect scheme of logical division. Any actual division that can be made therefore of animals, or plants or forms

[8] *Reconstruction in Philosophy*, pp. 154–5.

of government, would exhibit many logical defects; every classification involves compromise; the things, which it puts into the same class from one point of view, from another claim to be placed in different classes. . . .

"Thus the ideal which Logical Division sets before us is very different from anything which Classification achieves. Logical Division would fain be exhaustive, and establish constituent species which do not overlap; but a classification may have to acknowledge that there are individuals or whole classes which might with equal right be referred to either of two coördinate genera, or seem to fall between them, or outside them all." [9]

The limitation of classification with regard to system concerns us here especially, as any practical system must provide with sufficient adaptability for the several different purposes that it would serve and also for such changes as are likely to become requisite during its use.

A classification may be distinguished from a system in that its definition connotes classes in some intentional arrangement, merely implying the relations involved; whereas the definition of *system* connotes the relations as *essential;* and the relations may be more complex than the classes. But when in the tables of a classification the inter-relations are explicit in notes, so that it provides for different purposes, as do certain classifications for books in libraries, then the classification indeed becomes a *system.* This term was therefore put into the foregoing definition of classification.

A classification is an arrangement of classes in conceptual relations, is conceptual even tho many of the classes and relations may be real. If, however, real classes are arranged in real relations, the resulting classification may be regarded as real. Whether real or conceptual, a classification may be objectified in specimens or types or groups representing the classes, as in a museum or library or in an exhibit or show-window of a hardware store.

A divergent view is sharply expressed by Gibson: ". . . spatial grouping, such as that of the books on the shelves of a library, or the arrangement of a collection of butterflies in a cabinet, is in no sense a logical *classification.* It is an arrangement of *speci-*

[9] Joseph. *Introduction to Logic,* pp. 133–4.

mens, and not a classification of species. Again, the assigning of individuals to their respective classes, tho in itself a logical operation, is not a *classification of species,* but only a *classing of objects.* We may class specimens, but we cannot classify them." [10]

4. THE KINDS OF CLASSIFICATION AND THEIR TERMINOLOGY.

Natural classification is distinguished from artificial, or purposive; and scientific classification from arbitrary and practical. Other kinds are mentioned under their several terms. Purposive and practical systems should adaptively combine scientific classifications.

Natural classification is the term that has been used for a classification of natural kinds, classes, genera, species, etc., especially in the natural sciences. But such classifications may have a conceptual and often a purposive warp in their fabric. We should bear in mind that they are natural only in so far as they embody natural classes in real, or natural, relations. While the knowledge of natural relations is so incomplete, natural classifications are permanently valid only in special limited fields in the so-called *classificatory sciences.*

Mill extended the term *natural classification* not only to natural kinds but to kinds of objects that are alike to common knowledge and definable by essential or obvious characters; and of course many other logicians have followed Mill in this. But, as we have noticed before, Mill used the term *classification* also for *classifying* and for *classing;* and here we have a consequence of that ambiguity. It may be quite "natural" for men to classify such common objects, but the resulting classifications and the relations involved may be purposive or practical, *not* natural.[11]

"The Method of Natural Classification", wrote Whewell, "consists . . . in grouping together objects, not according to any selected properties, but according to their most important resemblances; and in combining such grouping with the assignation of certain marks to the classes thus formed." [12]

[10] *Op. cit.,* p. 65.

[11] See Mill's *Logic,* Book IV, Chapter VII, § 2.

[12] *The Philosophy of the Inductive Sciences,* 3rd ed., London, 1858, Part II, p. 230. The distinction between natural and artificial classifications was well stated by the eminent scientist Ampère in his *Essai sur la philosophie des sciences,* v. 1, p. 9; also by the recent German writer, Vaihinger, in *The Philosophy of As If* (1924), pp. 17–19.

But the term *scientific classification* is indeed justified in the much broader range of studies to which it is generally applied. Within the system of natural classes and natural relations there may be many classifications that are conceptual, or theoretical, or purposive, yet scientific, in the proper sense of this term.

As regards the terminology, the antithesis to *real* is *conceptual;* the antithesis to *natural* is *artificial,* formal, or conventional; the antithesis to *scientific* is *arbitrary,* or *practical.* The terms *conceptual, purposive,* and *diagnostic* may be applied to scientific and also to arbitrary and practical classifications; but purposive in this terminology usually implies purposes other than scientific. The terms *logical, formal,* and *rational,* sometimes opposed to arbitrary, or practical, and to natural, or *empirical* classification, are vague, because all classifying may be regarded as within the sphere of logic, and even a practical classification may have some *reason* for its arbitrary construction and it should in a sense be *formal.* The opposites would be illogical, irrational, and formless. The term *empirical* is applicable to such common-sense classifying as Mill was considering in the passage quoted.

The general antithesis between natural and scientific on the one hand and purposive, arbitrary, and practical classifications on the other hand concerns us especially, and how best to combine the special scientific classifications in a purposive general system is one of the major problems of this present undertaking. How shall the classifications of the several sciences, each with its special purpose, or viewpoint, and all overlapping each other more or less, how shall they be linked or woven together?

Purposive classifications, structurally considered, can hardly provide for as many arrangements of the classes, or groups, say in a library, museum, or store, as there may be purposes, interests, or views, brought to bear upon them, yet functionally they should be as adaptable as the conditions allow to changing relations, to new developments, and to dif-

ferent aspects. The purpose may be scientific in general, or special to a field of investigation or a science; or for some personal or social interest, or problem. A practical or arbitrary classification may have several purposes interwoven in its fabric, and this may be systematic. Or a single system may be adapted to serve more purposes than one. Further generalization on the relativity of classifications is needless here.[13]

5. THE FORMS OF CLASSIFICATION.

Serial and scalar classifications, branching and bifurcate forms, with subordinate and coördinate sub-classes and subdivisions, are distinguished, and cross-classifications. There may be complex combinations of these. The methods or principles of dichotomy, subordination, and coördination are related. Complex classification may be regarded as three-dimensional. Branching classification is likened to a tree.

Conceptual, arbitrary, and practical classifications may be of many forms, *serial,* or *branching,* or *diagrammatic,* or *cross-classification,* or some combination of these forms.

Division of a class by a single important difference (in the logical sense) produces two sub-classes, one having, and the other lacking, that distinguishing characteristic. Thus, the class *reference books* may be divided into alphabetic and those not alphabetic. Such two-branched, or bifurcate (two-forked), division is in the literature of logic termed *dichotomy.*[14] The resulting sub-classes may again and again be subdivided. The alphabetic books may either be dictionaries or not. The dictionaries may be in English or not. The English may be in one volume or in more than one. They may be bound in leather or not. Diagrammatically this dichotomous classification may be represented thus:

ALPHABETIC. Dictionaries: English: One-volume: Leather-bound.
Not leather-bound.
More than one volume:
Other than English:
Encyclopedias:

NOT-ALPHABETIC. Systematic Encyclopedias: English: Leather-bound.
Classified Encyclopedias: etc., etc.
Not encyclopedic: Handbooks: etc.
Not handbooks: Textbooks.
Not text-books.

[13] The principle will be re-stated in Chapter XIII, § 1.

[14] From the viewpoint of division dichotomy was defined and briefly discussed at the end of Chapter VII.

It is apparent that dichotomy produces *branching* or *ramifying* forms or structures of classification. But negative sub-classes are often indefinite or insignificant and their terminology may be very cumbersome. Dichotomy may therefore apply the positive terms only, tho in so doing its division may become less exhaustive or less complete, that is, some insignificant classes and subdivisions may be omitted from the classification. In a simple succession of *exhaustive* dichotomous divisions the negative or indefinite sub-classes, or branches, may all be discarded or cut off (*abscissio infiniti* in the terminology of logic). This leaves a simple series of successively subordinate sub-classes. Each sub-class is *subordinate* to its class. Exhaustive dichotomy (with negatives) thus may tend in the extreme to reduce to *serial, scalar,* or *columnar* classification. This method of exhaustive dichotomy is useful in some kinds of analysis and diagnosis but is too cumbersome for extensive use in practical classifications. Often there is but one difference (from the point of view assumed) for the division of a class into the two relevant sub-classes. In library economy it is customary thus to divide books *bound* from books *unbound,* — or otherwise in positive terms, *bound volumes* from *pamphlets.* But dichotomy with *alternative definite* sub-classes is always of branching form; and the two branches are of equal rank, are of the same order or stage of division, that is, they are *coördinate.* Alternative dichotomy is much used.

But often a class is divided by more than one difference into more than two sub-classes. Thus *reference books* may be bound in leather, in cloth, or in paper-covered boards; again those in leather may be in morocco, in calf, in pig, etc. These sub-classes, as thus subordinate, are of the same order, or coördinate.

Coördinate classes or sub-classes may be arranged in a linear, or horizontal, series, or in a vertical, or columnar, series. But this kind of series, or column, differs logically from that described as resulting from successive subordinations in exhaustive dichotomy. The two types of series differ as products, the one of the principle of *coördination,* the other of the principle of *subordination.* Coördinate classes are serial in the sense that they are successive in the same rank or order of division, as in progressive steps on a level grade. Subordinate classes are serial in the sense of successive divisions, additional specifications, and more and more specific or intensive definitions, or decreasing rank; and they

may be said to be analogous to a scale, or ladder, or tree.[15] Thus we have the series: bodies, organisms, animals, vertebrates, mammals, quadrupeds, ungulates, perissodactyla, equidæ, horses. It may be worth while noting here that only the first four terms of this series are dichotomous, the succeeding six terms being chosen from ranks successively subordinate in the series.

Coördinate classes or sub-classes may be measured or qualified with regard to some attribute and the series may be arranged accordingly. Thus the different leather bindings may be arranged according to their respective costs, or their durability, as measured by use; or they may be arranged according to some other property. With respect to this measure and arrangement each kind would be qualitatively or quantitatively inferior, or subordinate, to that which preceded it in the series. The series would thus be coördinate in one respect and in the other respect would be brought under the principle of subordination. This duplex relationship may be represented graphically by a scalar series of classes subordinate vertically and coördinate horizontally, or *vice versa* coördinate vertically and subordinate horizontally. A very important instance is that of the Natural Sciences arranged in order of *speciality*, each science being in one sense individual and coördinate with its fellow sciences, yet in another sense subordinate to that on which it is mainly dependent for concepts and principles and from which it is largely derived by specialization.

Subordination and coördination more often mingle in the complex arbitrary and practical classifications of the data of the several sciences, technologies, economies, and arts. Coördinate subclasses may be subdivided each into specific divisions, which may be treated either as in turn coördinate with one another or as progressively subordinate; and their division may be repeated and carried to any degree of subdivision. The class *garden vegetables* may be reduced to a series of four coördinate sub-classes: edible

[15] In the olden logic the dichotomous series was often called the "tree of Porphyry", or "tree of Ramus". See Coffey's *Logic*, v. 1, pp. 78–9.

roots, edible fruits, leguminous, and salad plants. Each of these sub-classes may be subdivided. The resulting series may have some members subordinate and others coördinate.

The term coördinate is applicable to classes or divisions of the same order of division. They need not always be of a single division. In some classifications subdivisions of different divisions or branches may be of parallel rank, and such might also fairly be termed coördinate, tho this would be in a diagrammatic, not in a logical sense.

An *alphabetic series*, or an *index* of classes (or their names), is the simplest form of practical serial classification. It may be argued, however, that such series are not classifications at all, for there is no relation between the classes except their contiguity in the alphabetic order.

Cross-classifications are duplex arrangements of vertical series, coördinate with regard to one principle or interest, *crossed* by horizontal series presenting other aspects. There may be as many horizontal series, and as many members in each of these series, as there are vertical series or columns. In such case the classification may be diagrammatically represented by a checker-board plan. But the vertical may not equal the horizontal series, and some of the series may have fewer terms, or more, or may be incomplete, lacking classes and presenting gaps. This form of classification, graphically set forth, is often termed *tabulation*. It is usually simple and unelaborate; and it is limited in applicability. Statistical tabulations may have equivalent *graphical* representations, or *graphs*. Functional relations are often represented by similar *graphics*. More complicated classifications too, whether scientific or arbitrary, may be represented by *diagrams*.

Detailed and elaborate classifications may combine all these methods or forms in any degree of complexity. In general the serial form is opposed to the branching forms. The terms *branching* and *expansive* are especially appropriate to scientific and to practical classifications.

Dichotomy, subordination, and coördination are thus seen to be related to one another. The latter two principles are

indeed complementary to each other in certain respects. But in classification by definition and division the principle of subordination is the more important.

A system of entities and relations may (as we have said before in several contexts) be surveyed from different aspects and traversed by diverse interests and purposes. There may accordingly be many classifications crossing or branching or interweaving in many ways. A one-dimensional serial classification has no structural reach and no functional grasp into this complex of ramifications. The application of such is very limited. Cross-classifications and two-dimensional graphs, or diagrams, are also inadequate; for they become congested with ramifying details that would really require three dimensions for their structural representation, or even four dimensions, if such could be represented graphically.

Such classifications may fitly be regarded as analogously three-dimensional. Each stage or grade of division, or expansion, may be said to be analogous to a dimension, the first to length, the second to breadth, or area, and the third to depth, or cubic contents, or capacity. We need not, however, carry the geometrical analogy so far as to suppose that the dimensions are rectangular; they are in truth merely relational subordinations. The main classes may be likened to the main branches of a tree or the rails of a vertical trellis, the divisions being likened to secondary branches, or to cross-slats, and the subdivisions to lesser boughs, or to smaller cleats transverse to the slats. Another applicable similitude is that of a building. The first expansion would be the ground plan, the second the stories, the third the hallways, passages, and rooms on the several floors. But such analogies are, we repeat, relational, not real.

It is sometimes said that theoretically, or logically, there should be only one principle of division in a series, or even in a system of classes; but in practical classifications there may be several principles combined or interwoven in the divergent branches. It is with purposive systems of branching classification of this more complex development that in subsequent chapters of this book we shall have to deal.

A tree in nature photographed against a winter sky, its intricate ramifications thus projected on a plane, is less complicated than the tree of knowledge with its million interweaving concepts, relations, and definitions; and it is with great difficulty that this tree of knowledge is trained, as it were, upon the trellis of classification. In all its details its branchlets reach out in all directions. It plainly occupies the three dimensions of space. And, if a fourth dimension were spatial, it would occupy that too.

6. THE PRINCIPLES OF CLASSIFICATION SUMMARIZED.

Fourteen principles, here summarized, are recapitulated. The relativity of knowledge is affirmed, the correlativity of class and class-concept, and the inclusiveness and relativity of classes. Groups are composite. Subordination and coördination are relative. Systems and classifications are synthetic, relative, and should be adaptive. General classes are relatively permanent. Collocation of related classes in functional classification effects maximal efficiency.

The foregoing definitions and discussions, in a field where definition is difficult and discussion reveals the inherent complexity, have brought out certain general principles that may now be re-stated as a basis for the logical and scientific classification of knowledge. It will later be our purpose to adapt such a classification to the *functional* organization of knowledge, and more especially to a system of classification for libraries. But before proceeding, it will be well to summarize the most important definitions and principles thus far adduced, lest we should forget how they rest on the very nature of reality and of knowledge.

I. The principle of *Relativity:* things exist in relations and by relations are conditioned or affected. (Chapter IX, §§ 1 and 2).

II. *The Relativity of Knowledge:* knowledge is correlative to objects, or realities, and to subjects, or minds; and knowledge is of things in relations, and of the relations. (Chapter VI, § 1, and IX, §§ 1 and 2).

III. *The Correlativity of Classes and Class-concepts:* classes are correlative to class-concepts and also to class-names. (Chapter VI, § 1).

IV. *The Relativity of Classes:* classes and concepts are relative to existential relations and to knowledge relations, and are developmental and adaptable. (Chapter VI, § 1).

V. *The Inclusiveness of Classes:* a class comprises all the things that are like to its concept and defined by its definition. (Chapter VI, pp. 120 and 132).

VI. *Groups* are *aggregates,* or *composites,* are selective, may be of several classes, are localized or enumerable, and are temporary; they are not comprehensive, not totalities, as classes are. (Chapter VI, § 4).

VII. To *General,* or generic, classes are *subordinated* the *specific* and successively the more and more specific and analytic classes. (Chapter VI, p. 121, and VIII, pp. 152–3).

VIII. *Subordination* and *Coördination* are *relative* and *complementary.* Serial, branched, and crossed structures may therefore be combined. (Chapter VIII, § 5 and p. 249).

IX. *Systems* are *synthetic* of *classes* and *relations.* (Chapter VIII, p. 148, and IX, pp. 168–9).

X. Classifications should be synthetic, developmental, and adaptable. (Chapter VIII, pp. 150–1, 237–9, and 244).

XI. *The Relativity* and *Plurality* of *Classifications:* arrangement, whether serial or systematic, implies conformity with some natural order, or some conceptual order, or some purpose or interest. (Chapter VIII, pp. 147–8 and 150–1, and Chapter XIII, pp. 238–40 and 243–4).

XII. *Natural* and *Scientific Classifications* should conform to the Order of Nature as closely as is feasible. (Pages 186, 231, 239, and 244).

XIII. The *Relative Permanence* of *General Classes,* or of *Main Branches* of science. (Chapter XI, § 5, XII, § 2, pp. 209, 211, 219, 222, and 231).

XIV. *Collocation of Related Classes* effects *Maximal Efficiency* in Practical Functional Classification. (Pages 146, 238, 301, and p. 408).

CHAPTER IX

RELATIONS, SYNTHESIS, AND SYSTEM.

1. RELATIONS.

All things exist in relations. A relation implies the things related. A thing in relation is distinct from the same thing apart from that relation. Internal and external relations are distinguished. A relation external to one system may be internal to a more comprehensive system. Relations are not existent, but they may be real. Likeness is distinguished from sameness and from identity.

Relations are modes of existence, or conception, which condition or affect the things they relate. All things, real or conceptual, exist or subsist in relations of some kind. Conversely, *a relation implies the things related,* and without things related there can be no relation. There could be no subject-object, or knowledge, relation without subjects and objects. There could be no relation between real things and concepts, if the things were non-existent or inconceivable. Whether the concepts and the relations may also be regarded as real or existent is an important question, which will be answered presently. A relation may affect any or all of the things likened in a *class,* which may be defined with reference to that relation.

A thing and a relation, or things in relations, form a complex distinct from any of its components. Thus the things A and B in a relation r compose a complex ArB, which is different from A and from B, also from Ar and rB. For example, a padlock, its key, a hasp, and staple, together with the requisite screws, compose what may be termed *a padlock combination,* each part of which is distinct but the whole dependent on the combination of the parts. The padlock is one thing, the key is another, and the correlation of this key to that lock depends on the parts of each being made so as to fit. Again the padlock with the key in it, or in relation to this key, is different from the padlock apart from this relation; and the same

may be said of the key, and of the hasp. If either were lost, the relation would no longer be actual. The padlock is dependent on the key, is incomplete without it; and the key would be useless without the padlock. But the relation of the padlock to the hasp is merely contingent, for with another hasp the padlock could be put on another door. To the complex the components and the relations are internal, or intrinsic; to the components these same relations are external, or extrinsic. *A relation may be external to one complex while it is internal to a more comprehensive complex or system.*

Relations may be perceived or conceived in various complexes or situations; they may be represented by various means; but they are not existent as are things. They are not easily conceived apart from the things they relate, and conversely, the things may hardly be separable in thought from the relations. Yet relations are not qualities, and, even when internal, or component, they are not *parts* or organs of the complexes or organizations. *They are not existent, but they may be real.* The relation of contact of two bodies is as immediately apprehended and as real as are the bodies themselves, or their qualities. The relation of an acorn to its oak-tree is certainly real while it remains where it grew on its twig. Otherwise the relation may be conceptual. We may therefore conclude that some relations are real and some conceptual, and some may be either particular and realized or generalized or conceptual.[1]

The generalized relations that especially come within the field of this discussion are those of part to whole, of organ to organism or organization, of component to group or complex, of individual (or member) to class, of class to class-concept, of name, and of definition, to the class, of class to class, of concept to concept, and of class (or concept) to complex (or system) of classes, or classification; also the relations of

[1] These distinctions are stated here in the interest of precision. But this difficult philosophical problem cannot be disposed of in a few sentences. More adequate treatment, however, would take us too far afield. If any reader should be interested in the writer's views, they may be found in two articles "On Relations" and on "The Subject-object Relation" in *The Philosophical Review*, v. 24, pp. 37–53, and v. 26, pp. 395–408.

likeness, of dependence, of contingency, of subordination, of coördination, and of series.

The *likeness* by which things are classed is a relation; it is *not* a quality or property of the things; it is just the *relation of likeness* depending on like qualities, properties, parts, characters, attributes, or accidents.

This is indeed a close distinction, yet necessary to precision. We should furthermore carefully distinguish between the meanings of the terms *like, same,* and *identical.* Briefly, things may be like in some character, property, or relation, or set of these, yet not be the same. *Same* may be defined as like in all properties, characters, and *internal* relations. *Identical* is same in individual existential relations and in external relations determining individuality. Two pins may thus be the same, but are not identical. Identity does not, however, preclude change whether in external or in internal relations. The clock on the wall is the identical clock that was there an hour ago, though it does not look the same, as its hands are not in the same position. But that external appearance does not affect its internal sameness to another clock of the same kind in another room, nor the identity of this one, if it should be placed where that one now is. I might say that this is the identical coat I wore yesterday, but that it is not the *same,* for it now has an irreparable rent in the sleeve. I must try to purchase another something *like* it.

In some cases likeness is not perceptual or apparent; it may depend on some *internal,* intrinsic, inferred, or imagined resemblance or analogy. Thus the series of prime numbers up to 29 are like in that they are divisible only by unity and by themselves. Again, the symbols carved on the monumental stones of a cemetery are like in their escatological significance.

The questions whether likeness is real and whether relations are real no more permit of categorical or dogmatic answer than does the prior question whether classes are real. Our answers to these questions must be qualified first by the terms in which we have defined reality,[2] and further by the sense in which the things are real and their relations or properties are realized.

[2] *Cf. supra,* p. 129.

2. THE RELATIVITY OF KNOWLEDGE.

All things and all knowledge are relative to viewpoints, to standards, to criteria. The principle of *relativity* is not new. The validity of some of Einstein's implications questioned. The relativity of knowledge is implied in the relativity of classes.

All experience, all knowledge, all ideas, and all thoughts are related to things and thence to other things, whether real or conceptual, that is, they are relative; they are in their several ways relative to spatial and temporal relations, and they are relative to individual minds, and thru these to communal minds. No fact of experience, no datum of knowledge is isolated from other data and from the relations that condition its existence. All measures, all qualities, all values are relative to standards, to points or coördinates or frames of reference, to origins or causes, to minds or interests or needs or tastes. What we regard as discrete objects, or as individuals, are separated from other things only in our relative perceptions and thoughts and for present interests and convenience. Even so, they are regarded in some of the relations, while others are disregarded. At another moment they may be viewed in other relations or by other minds and may then appear quite otherwise. This implies the principle of the *relativity of knowledge*. The principle of the *relativity of classes* is implied in that principle.

The disconcerting doctrines of Professor Einstein, which for a decade or two have exercised the minds of mathematical physicists and philosophers, seem to depend in some subtle manner upon the relativity of physical data to spatial and temporal relations. Thru the misappropriation of the term *relativity* some scientists appear to have become obsessed with the notion that the principle of relativity has hitherto been overlooked or neglected or that its implications have been treated inadequately. That may be partly true, but that claim should not be overworked. The physicists should not be so star-struck by the deflection or aberration of a star's ray, even if certain mathematicians find therein vague arguments for the doctrines of curved transmission or "curved

space". All radiations and attractions, even gravitation, may indeed prove to be affected by electromagnetic action. What then, if there be deflection of a star's ray passing close to the great solar magnet? What then, if there be an *entrâinement,* or traction, of the medium of radiation by the magnetic Earth? What if the hypothetical æther be as unreal as its ascribed properties are self-contradictory? What if observations and experiments conditioned by terrestrial methods and measures fail to capture the immensities of cosmophysical magnitudes and velocities? Well then, something may be disproved; but nothing else is thereby proved. What of relative velocities and measures conditioned by relative motions? Do certain "relativists" maintain that radiations are propagated thru space at a constant speed that is the maximum of physical possibility? That itself were too much like an ætherial absolute. That Einstein postulate is thus linked to an assumption that is *not* relative. But the principle of *relativity* was understood long before the theory of Einstein appeared like a flaming comet on the firmament of Physics, and it was understood better than is now the Einsteinian doctrine. The principles of the relativity of knowledge, of *data* to *relata,* of relata to relations, of measures to units, of units to standards, of standards to criteria, — these principles are as old as the very hills of science.[3]

Years before Einstein was heard of, Pearson in his *Grammar of Science,* published in 1892, stated the principle simply and adequately as regards position, motion, and measure.[4] Then in 1901 Baldwin's *Dictionary of Philosophy* defined the principle as applying to spatial relations in general. Mach's *Space and Geometry* treated the relativity of spatial relations as a postulate of physical science. (See the translation by McCormack, Chicago, 1906, p.

[3] "It is to be regretted that the title 'Theory of relativity' was ever appropriated to the extent it has been for Einstein's doctrine, just as if it belonged to that doctrine in a special way. What he is concerned with is relativity in measurement in space and time only, and relativity extends to other forms of knowledge as much as to that merely concerned with quantitative order." — Haldane, *The Reign of Relativity,* p. 125.

[4] (See the chapter on "The Geometry of Motion", § 7, "Point Motion. Relative Character of Position and Motion").

140). These three citations to well-known books in English happen to be at hand. It would not be difficult to find three hundred in the literature of physics and philosophy prior to 1905, when Einstein commenced to propound his doctrines.

These strictures refer only to the physical, kinematical, and logical implications of the doctrines. The mathematical implications are relegated to those mathematicians who proclaim Einstein as their very own, asserting that no other class of thinkers can comprehend his doctrines. And that seems to be the scientific situation. What has been proclaimed as a revolution in mathematical physics appears to be a vaguely argued theory, admittedly unintelligible to non-mathematical minds and involving such infinitesimal differences from equations of classical mechanics as result from factors divided by the square of the velocity of light. By what realities are such modifications of theory required? Is the negative result of the historic experiment of Michelson and Morley indeed obviated by such a difficult detour? Does a discrepancy in aberration of light passing the sun's disc really depend on such a hypothesis for its solution? Is that acclaimed verification of the theory, or is that from accounting (supposedly) for the discrepancy in the orbit of the planet Mercury truly conclusive? The writer raises these questions, declaring that he is not competent to express an opinion and confessing his inability either to comprehend or to confute the theory, yet doubting the scientific value of its extensions to a generalized mechanics. But what he would emphasize in this context is merely that the principle of relativity is much older, broader, clearer, and more applicable, and that to have thus misappropriated the term *Relativity* to the vague theories of Einstein is a mental misfortune to science and philosophy.

3. MENTAL SYNTHESIS

Synthesis, the composition of components, or of classes, or of concepts, is antithetic to analysis. It too may be purposive. Mental synthesis puts relevant concepts together in systems of knowledge and thought. It is closely correlative to mental development. Mind consists largely in the products of synthetic mental processes. The synthesis of concepts may extend to any degree of complexity and comprehension.

The term *synthesis* is used by scientists in contradistinction to *analysis,* which is discriminating and purposive division, whether physical or chemical or logical. Synthesis too is by implication purposive. Synthesis is more than the reverse of division, for from the divisions and subdivisions of a multiplicity of classes not only the original classes may be reconstructed but new classes or complexes of classes may

be formed. It is this originative or inventive synthesis that is so valuable to the progress of knowledge, of thought, and of life. And it is no less a clarifying process than is the classifying on which it rests. For synthesis mentally relates concepts of relevance to some principle or interest, even as classifying arranges classes in relation to some principle or interest. Synthesis is concerned with constitutive relations rather than with mere likeness. It is conceptual rather than perceptual, and purposive rather than arbitrary or spontaneous.

The reciprocity of analysis and synthesis is obvious. Analysis is like taking a thing to pieces and placing the pieces about the center of interest. Synthesis is like taking the pieces to the thing, either replacing them systematically in the thing that is the center of interest or putting them into coherence in some cognate system of relevant interest. The less the disorder in the analysis, the less the trouble in the synthesis. If the jeweller, in taking the watch to pieces, drops these anywhere on his table, he will have a heap of trouble to find and replace them. This need of order and system in mechanism applies no less to organization. It applies especially to an organization of knowledge.

Mental synthesis is more specifically the psychological, rather than logical, process of putting relevant concepts together and interrelating them in the systems of knowledge and thought, and so in *mental development*. The three processes, synthesis, mental synthesis, and mental development, are intricately involved in the life of the mind.

Mind, as distinguished from *consciousness* and from *mentality,* largely consists in the coherent and developmental products of mental processes comparable to sorting and storing, arranging and rearranging of materials, that is, to classing and synthesis. Those mental products are impressional, mnemic, perceptual, and conceptual, and from them arise and develop the infinitely various mental activities, meanings, interests, and responses, and the systems of knowledge,

thought, and purpose.[5] These psychological inferences are implied in the customary phrases, a well-ordered mind, correct and ready knowledge, clear thinking, systematic treatment, competent diagnosis, etc.

"The function which modern philosophy seized upon as expressing the vital essence of mind was that of bringing things together so that they have a bearing upon one another. Where there is mind there is order and system. . . . Where there is no mind at work . . . action is random, isolating, conflicting." [6]

In mental development the process termed synthesis originates in the formation of complex concepts and complexes.[7] It develops into the more conscious and purposive *organization of knowledge.* Originally concepts are related in association or in thought, and these relations may become so persistent that the concepts may, as it were, cohere or coalesce in more complex and more comprehensive conceptual formations. We must not, however, allow these terms to rest on physical analogies, for these processes, of which our thought is so introspectively obscure, are *mental.* But the complex concepts may developmentally comprise larger and more comprehensive syntheses.

4. THE UNITY OF REALITY AND THE UNIFICATION OF SCIENCE.

Existentially or conceptually relations interweave systems more and more comprehensive. The unity of the universe inheres in the unity of these relations; and to that unity the unity of knowledge is correlative. The system of knowledge may be traversed either analytically or synthetically. But is synthesis as true as analysis? Thru true, coherent knowledge reality is progressively revealed.

Relations link and interweave things, concepts, classes, and even relations, in complexes and systems. By relations the

[5] The following phrases from Professor John Dewey's *Experience and Nature* support the view expressed here: "Mind denotes the whole system of meanings; . . . "Mind is contextual and persistent; consciousness is focal and transitive. . . . "To denote the characteristics of mind . . . organization, order, coherence. . . . "The connected whole is mind, as it extends beyond a particular process of consciousness and conditions it." (pp. 303–7)

[6] Hobhouse, *Mind in Evolution,* p. 6.

[7] "A complex is a system of associated mental elements, the stimulation of any one of which tends to call the rest into consciousness through the medium of their common affect." — Tansley, *The New Psychology,* p. 49.

discrete objects, or individuals, are classed and classified, and by relations the classes, complexes, and systems are interwoven into the most comprehensive system, the *universe*. The *unity* of the universe inheres in the constancy and coherence of these relations, but especially in the spatial, temporal, causal, and genetic relations, all of which are universally inherent.

The unity of knowledge is correlative to this unity of the universe. It depends on coherent and realistically on true knowledge of the *real* relations. This unified knowledge of reality is one of the highest purposes of science and philosophy. If, however, the universe were but an ideal, its unity would be conceptual; and it is to this that the unity of knowledge would then be correlative.

What especially concerns us in systemizing knowledge is that the constitutive relations may be mentally traversed either outwards to the limit of comprehension, or inwards from the most comprehensive or general to the most intensive or special; in other words, the system may be either *synthesized* or *analyzed*. To bring the thought home to the main interest in this book, we may either *classify* or *systemize*.[8]

In terms of unity and simplicity these antithetic processes of mind were a leading theme in Henri Poincaré's great address as President of The International Congress of Physics at Paris in 1900.

"Dans l'histoire du développment de la Physique, on distingue deux tendances inverses. D'une part, on découvre à chaque instant des liens nouveaux entre des objects qui semblaient devoir rester à jamais séparés; les faits épars cessent d'être étrangers les uns aux autres; ils tendent à s'ordonner en une imposante synthèse. La Science marche vers l'unité et la simplicité.

D'autre part, l'observation nous révèle tous les jours des phénomènes nouveaux; il faut qu'ils attendent longtemps leur place et quelquefois, pour leur en faire une, on doit démolir un coin de l'édifice. Dans les phénomènes connus eux-mêmes, où nos sens

[8] "The progress of science is duplex. It is at once from the special to the general, and from the general to the special. It is analytical and synthetical at the same time." — Herbert Spencer, *Genesis of Science*, in *Essays*, v. 2, American ed., p. 24.

grossiers nous montraient l'uniformité, nous apércevons des details de jour en jour plus variés; ce que nous croyions simple redevient complexe et la Science paraît marcher vers la variété et la complication." [9]

Our next concern, and not less important, is whether knowledge and reason proceed outward in synthesis as truly as they proceed inward in analysis. Another way of phrasing this question is whether thought discovers, or conceives, reality as truly as perception analyzes nature. On this depends the validity of comprehensive classifications of science, and especially the order of natural classes and real relations which mainly constitute what we describe as the Order of Nature. To this revelation or ideal of the human intellect scientific and philosophic thought have long been progressing. The reality of the universe and of the order of nature have for most intelligent minds become veritable foundations of intellectual faith.

But, while knowledge is imperfect, these relations, this order of nature, this universe, tho not unreal, must be largely conceptual. Knowledge, however, is progressive; and the concept of the universe is, we believe, progressively developing. In both senses, the subjective and the objective, reality is progressively *realized*. So we believe; so our intelligence becomes clearer and more comprehensive. This belief and this intelligence amply justify science and philosophy in their synthetic purpose to achieve a unity of true knowledge and to comprehend, even if they cannot with certitude explain, the system and the order in the realistic universe.

At the Congress of Arts and Science at St. Louis in 1904 the President, Professor Simon Newcomb, plainly stated the problem of organizing science, which the events of the years since then have but pressed upon scientific minds with intensified urgency. "The problem before the organizers of this Congress was, therefore, to bring the sciences together, and seek for the unity which we believe underlies their infinite

[9] *Congrès International de Physique, Rapports,* p. 23.

diversity." [10] That high purpose was repeatedly echoed in that Congress and was contemplated in these sentences of Professor Münsterberg in his introductory address:

"Our time longs for a new synthesis. . . . It waits for science to satisfy our higher needs for a view of the world that shall give unity to our scattered experience. The indications of this change are visible to everyone who observes the gradual turning to philosophical discussion in the most different fields of scientific life.

"What is needed is to fill the sciences of our time with the growing consciousness of belonging together, with the longing for fundamental principles, with the conviction that the desire for correlation is not the fancy of dreamers, but the immediate need of the leaders of thought." [10]

5. SYSTEM AND THE UNIVERSE.

System and organization are dominant tendencies involving classification. Natural systems are discovered, and with those are combined conceptual systems. The supreme system is the universe, the totality of relations real and conceptual, the supreme object of knowledge and of purposive intellectual synthesis.

The unity of science, or of reality, may be an ideal, but *system* is a present, recognized, dominant tendency in knowledge, in social, and in industrial organization. System and organization are nearly synonymous terms. System is a matter of classes, of relations, and of synthesis. Wherever things are classed and the classes are combined in larger classes and are put in some *order,* there are the beginnings of system. The classes may be natural or conceptual, and the relations linking them may be either real or ideal, but, if coherent and orderly, the classes, relations, and complexes constitute a system. The relations may be very complicated, or they may be comparatively simple. Many interests, doctrines, or theories, may be interwoven in the web of relations, which may be not only actual but virtual, or potential. Or a single purpose, a natural, an ethical, or an intellectual interest, may predominate and the system may develop about this purpose.

[10] *Proceedings,* v. 1, pp. 145, 92 and 93.

By analytical and synthetical processes, by conceptual abstraction, and by scientific induction, the human intellect discovers certain *natural systems*, constituted of like forms, coherent relations, persistent forces, recurrent actions, reproducing individuals, and self-perpetuating species. But, besides these natural systems, the mind selects from the world of realities, from the manifold entities and relations, many systems that are truly conceptual; in brief, synthetic thought constructs conceptual systems of real objects. Our intellectual, spiritual, and æsthetic life subsists largely in these conceptual systems. Our societies, *mores*, religions, arts, and studies, all embody and in some measure systematize certain ideals, interests, and purposes that are attributed to the mind of humanity and "the spirit of the times".

Because of this idealizing tendency, and in so far as knowledge is incomplete and thought is fallible, our science and philosophy render but an imperfect replica of the reality which the intellect aspires sometime to comprehend more adequately and truly.

Natural systems are modified or transfused by conceptual relations, by ideals, and by purposes. Conceptual systems indeed are constituted of entities, some real, some ideal, subsisting in relations that are mostly conceptual. Thus all systems, whether scientific or economic, ethical, æsthetic, or practical, have some conceptual components, are in some respects conceptual.

Synthesis tends ultimately to comprehend a unified knowledge, and this intellectual tendency becomes purposive. The supreme system of systems is the universe, the totality of entities and relations, of all things existent and potential in all relations real and conceptual, the most comprehensive object of knowledge and thought, the ultimate reality and, in the idealistic philosophy, the supreme concept.

CHAPTER X

THE ORDER OF NATURE.

1. SCIENTIFIC REALISM AND THE MONISTIC UNIVERSE.

Tho denied by some thinkers, the order of nature is in our realistic science and philosophy realized as inherent in nature and the universe. The relation of the whole to its parts is implied. This realism is consistent with a doctrine of universal Mind, Purpose, and Energy.

In the days of the famous Bridgewater treatises, when natural science was in its callow youth, the Order of Nature figured so prominently in "the argument from design" that it came near confirming religious faith by proving the existence of Deity as a *person* purposing, conceiving, and maintaining this Order. Since then our ideas of the nature of God and of the Order of Nature have developed in the light of increasing knowledge and intelligence.

But some thinkers deny that there is anything like order in nature; others deny the reality even of what we call nature, and of the universe, while still others negate the very existence of the external world, which they assert is merely a concept of mind, a creation of imagination, a persistent illusion. Idealists have long declared that the only realities are ideas; that entities and relations are but conceptual, that the world is nothing but a supreme concept. It is only as part of this conceptual system that they admit the verity of the relations that are the subject-matter of scientific studies; and they argue that there is no certitude even in the principles of uniformity and continuity, of law and of cause, nor reality inherent in time and space. The kindred philosophy of voluntarism maintains that all existence, all reality, and all knowledge emanate from the Will that motivates the creative Mind.

This doctrine proceeds from religious beliefs that we need not discuss in this book.

Nor need we pass critical judgment upon the course of philosophic thought. What does concern us here is that the minds of many scientists have been affected by religious predispositions and metaphysical predilections. Empirical science, however, does not blend well with transcendental philosophy. Yet to rational philosophy resting on experiential knowledge we are led by the relevant questions of the relations of empirical knowledge to rational truth, of truth to reality, of reality to existence, and of existence to cause.

In preceding pages the philosophy of realism has been affirmed. Realism may be briefly defined as the doctrine that *things exist independently of our knowledge of them.* This doctrine maintains that objects are external to subjects, and that concepts are *not* independent of objects; that *external* means outside of in a physical sense; that what enters the mind, or the brain, is not the object *per se* but either some sense-impression produced by some physical action transmitted from the object, or else some idea, somehow derived from an external object or subject; that these external objects are existent things and are realized in properties, qualities, actions, and relations that are inherent in them or constitutive of them; that these entities, tho imperfectly known, are progressively discovered; that their real existence, or reality, is thus antecedent to the knowledge, or realization, of them by individual minds; that each subjective mind is dependent on an individual objective human body, and that communal minds, and ultimately the general and the universal mind, must inherently subsist in the minds of associated and assimilated individuals.

This last clause involves the relation of the whole to its parts, in the special form of the relation of the community to its component minds. The relation of the whole to its parts, however, while reciprocal to the relation of the part to the whole, is not the same, is not "symmetrical", as the

logician terms a relation that holds equally both ways. The whole in this special sense is not merely a sum, or a totality, of parts, but is, as progressive analysis reveals, a system of inter-related parts. An organism or organization is dependent on its parts, tho perhaps not on all of them at once; but without all its parts an organism is incomplete, is lacking in some function or relation. Conversely in any whole the parts are specifically affected by their relations to one another *and to the whole*. In organisms and organizations the parts may in certain respects be causally, genetically, dynamically, or psychically, *dependent on the whole*. Thus, moreover, more complex entities and systems may be ultimately dependent on the supreme system, the universe. Our realistic doctrine therefore is consistent with the theory or belief, whether scientific, philosophic, or religious, that the existence, the properties, the actions, and the relations of entities, and even human minds and the knowledge in them, are determined and dependent on universal Mind and Purpose.[1]

Whether these teleological implications be affirmed or denied, realism maintains that physical, or objective, entities exist independently of any knowledge of them in individual subjects or in communities of minds. This doctrine of natural, or scientific, realism is opposed to subjectivism, to phenomenalism, and to objective, or absolute, idealism. Upon analysis and reflection it becomes "critical".[2] It should not

[1] The teleological implications are well sustained by Hobhouse in his *Development and Purpose* in passages on pp. 313, 316, 318, 319, 327–8, and 372.

[2] The writer's own view differs from that of the *Essays in Critical Realism* in that he does not regard the correlation of percepts, perceptual objects, or knowledge, to the existent, or physical, objects, or realities, as complicated by the mediate category of *data* consisting only of the *essence* of the objects and without their existential relations. Data are merely correlative to objects, or to percepts. Appearances are not entities, but are merely perceptual in relation to perceiving subjects; or, better, appearance is merely this relation. The only real media are those of transmission and transmutation of the physical into the psychical. This criticism applies also to Bertrand Russell's *data* as mediary between physical objects and mental sensations (as argued in his *Problems of Philosophy*), and also to Broad's *sensa*, similarly mediary as expounded in his *Scientific Thought*, Part II.

be mistaken for "crude realism" or "*naïve* naturalism", nor for materialism. It may be positivistic; or it may be pluralistic; but, as adumbrated in these pages, it tends to become monistic in its ontology, and to affirm the reality of the universe.

2. WHAT WE MEAN BY NATURE.

Nature and the _universe_ are defined and distinguished from the _world_. The order of nature is very complex, and is developmental.

Nature is our term for the system of *real* things and relations external to human minds and underlying the works of humanity. The classes of natural objects and the relations that subsist among them are *objectively* regarded as conforming in their properties, actions, and motions to constant relations and forces. This is sometimes termed a mechanistic system and a naturalistic view. Realistic philosophy, however, comprehends much more than that.

The *World* in the common sense comprises not only Nature but also the works of mankind. The term is often distinguished by this connotation. But, as human nature and all the works of man are grounded in nature, physical, biological, and geographical, the separation in thought is untenable in science. For man too, even in his mind, is a part of nature, and his works, his buildings, his gardens, his machines, and his pictures, are made out of materials, the rocks, the ores, the plants, the pigments, which he has taken from nature. The world, however, is permeated and to a large extent pervaded by man's *immaterial* works, his systems of society and government, industry and art, morality and religion, belief and science.

The *Universe* is more comprehensive than the world in which human life and thought abide; it comprises not only the world that is known to men but the whole system of nature and the whole of reality, even extending beyond the

present ken of astronomers, physicists, and psychologists to reality that may in the future be discovered, because determined by and subject to the same physical relations, forces, causes, and laws as now condition known realities. It may, moreover, be regarded as comprehending not only all reality but all existence, even the unknowable. Thus the universe is all-extensive and all-comprehensive; and it is unitary. By these connotations the term is distinguished from *Nature* and from the *World*.

Whether the universe is wholly *real* depends on the definition of reality. If defined as we have essayed to define it in terms of *verity* and *verifiability*, reality would progressively extend from known entities to *knowable entities*, but *not* to *unknowable* entity and *unverifiable* existence. There exist, as we suppose, things that are forever unknowable to human minds. Some of these may indeed be close to our hands or eyes. Real things about us may have elements that remain imperceptible, occult, and unreal. The moonbeam, the rainbow, the wireless message, the man, the distant mountain, the bottom of the well, or the bed of the sea, have, or may have, something of the unreal in them, in their components, their causes, their changes; yet in the ordinary sense, as opposed to the ideal, those things are real; as opposed to the wholly unknowable, they are at least in part known and realized, are in part veritable, and in so far are real. The reality of existent things, of systems, and ultimately of the universe, is accordingly incomplete, qualified, and conditional. It is with this understanding that we may say that the universe, comprising the whole of existence, known and unknown, is real.

In poetry and in some philosophy Nature is regarded as activating, even as purposive and creative, the *natura naturans* of the scholastics, as opposed to the objective *natura naturata*. The concept is similar to certain concepts of God as the immanent Energy and causative Purpose in the world.

In science, however, Nature is further distinguished as more systematic and more coherently knowable than the world generally. This idea arises from the realization of the conformities of recurrent phenomena to *constant relations,* that is, to natural laws.[3] For the cumulative experience of mankind and the consistent verifications of science lead to belief in this constancy and coherence in the relations of natural objects, actions, and changes. This belief, or certitude, validifies the concept of the Order of Nature. On this depends the philosophy of naturalistic realism.

It is no simple order that is thus conceived, not spatial and temporal merely, nor merely developmental, relational, or classificatory, but all of these together, and much more. The system of relations is so complicated that it has long baffled the understanding of the best minds to comprehend it in a universal theory or law. A law of universal application, such as the law of gravitation, is merely relational and is but a part of the whole system. Yet the universe is comprehensible, as knowledge, tho imperfect, comprehends the real.

The concept of the order of nature is as synthetic and as super-personal as is scientific knowledge; and it is very plastic and developmental. New knowledge and new thought are constantly assimilated to it. Nor is the order as a reality static; for nature is dyanmic in actions, is functional in changing and adapting structures, and is evolutional in the forms of living organisms. While some of the relations that are constitutive of those structures and systems, organisms and organizations are constant, other relations are variable. So the order of nature *per se* is plastic and developmental.

[3] "Such laws enable us to imagine the conditions under which all phenomena may be assumed to take place, in this manner to classify events which are widely separated in time and space, and thus gradually to approach more nearly to a conception of the world in which the infinite diversity of phenomena gives place to a very large number of classes of phenomena." — Henderson, *The Order of Nature,* p. 195.

3. THE CONSTITUENT REALITIES OF THIS ORDER.

The more important principles and relations are *seriatim* defined and briefly discussed: stability, persistence, and conformity to constant relations, variability, and adaptability; coherent interrelation, recurrence, and functional relations; genetic, developmental, evolutional, mnemic, and social relations.

The Order of Nature, as conceived and realized in science and philosophy, in experience and in prediction, consists of certain relations and definite orders of entity, or *categories*. The following may be named and, without profound ontological analysis, may be defined as relevant to our purpose. Some of these have been defined or discussed in preceding chapters; others require a brief statement here, tho to explain them fully would take more room than we can spare.

The stability and persistence of substance, or matter, and of constitution or structure, in elements, properties, components, and systems, underlying all change and flux of phenomena, are realities coherently verified by cumulative experience in the individual and in the race. Otherwise the world would be an evanescent, collapsible bubble in empty, imperceptible space; duration would be a dream vanishing in a two-dimensional perspective, and *nature* an impalpable shadow in the imaginary void. The first principle of the order of nature is the stability of substance and the persistence, or "conservation" of matter and of energy.

The *conformity* of bodies, structures, organisms, and systems to *constant relations* is amply evident in all fields of experience and knowledge. On this depend the knowledge and intelligibility of the world, imperfect tho the knowledge be and meager the intelligence. Without this coherence in nature there would be no consistency in life and in mind; neither instinct nor habit nor judgment nor reason could avail for conduct or thought; there would be no intelligence, no valid science, no stable organization of knowledge or of society. There would be but a helter-skelter mêlée of mere particular things and individual experiences and events in a pluralistic universe traversed by kaleidoscopic views or vistas of reality.

Plasticity and *elasticity*, impressibility and reaction, variability and adaptability of bodies, forms, organs, and systems to varying actions and relations, these properties are, however, not inconsistent with the principles of stability and conformity. There are plastic bodies of stable constituents; there are variable forms of persistent components; there are adaptable systems of coherent structures.

It is by *orderly and coherent interrelation* of certain materials, elements, constituents, and systems that organic bodies and adaptable organizations are sustained as plastic and vital in the various functions of life and activities of society. If this were not so, spontaneity, originality, and individuality would run riotously thru a chaos of confusions, in which there would be no norms of conduct, no beliefs, no morals, no criteria. Manifestations of such disorderly tendencies indeed at present appear reeling thru the streets of our civilization.

On *likeness, recurrence,* and *conformity* in natural phenomena and relations depend the common-sense expectation and the scientific prediction that increasingly enable men to acquire control over natural forces and resources. For often where the *causes* or *laws* are known the natural effects can not only be foreseen but forestalled or modified or even mastered by human action, individual or collective. The scientific and historical investigation of determinative relations and of efficient causes is motivated not only by the desire for knowledge and intelligence but also by the need for technical production of economic goods, defense against the inclemencies of nature, and even control of certain accessible physical actions and available energies. This applies to some extent to temporal and spatial relations, as may be exemplified by certain acoustical devices culminating in radio-communication; it applies in a limited way even to psychological and genetic relations, as in plant-breeding, alteration of personality by modifying the endocrine secretions, and control of inheritance thru eugenics.

Correlation is reciprocal relation or interdependence of occurrences that are recurrent in time or concomitant in spatial distribution, or causally dependent in statistical aggregates. Data or groups of data follow or accompany the correlative data or groups of data. The correlation may be statistical, approximate, or exact; and it often may be expressed or measured mathematically.[4]

The term *functional relation* denotes in physiology one kind and in mathematics another kind of relation, both of which are very important in the order of nature. In physiology the function, or action, of an organ is, as we have said before, correlated with its structure and anatomical relations. By analogy the term is applied also to the activities or services of members, or parts, of the *functional* organizations of society, industry, business, or government. In organisms and in organizations there are functional relations. In mathematics on the other hand the term *function* denotes a definite correlation, or correspondence, of a class, or series, of numbers, quantities, or other mathematical entities, to a certain other class, or certain other classes, of such entities. These classes, or series, of elements may also be conceived as *variable* numbers or

[4] *Cf.* Edman, *Human Traits,* p. 406.

quantities; and the term *function* is usually so defined. Any number or element or instance of the class, or series, is then termed a *value* of the variable. To each value of the one variable there corresponds a value of the other variable, which may be dependent on it, or determined by it. The variables are functions the one of the other. These relations are functional relations. Conceptual in mathematics, they become real in physical science and technology, especially in the graphical representation of physical, biological, and statistical data, of definitely variable dynamic actions, and of definite correlations.[5]

Genetic relations are so very obviously constitutive of the order of nature that little need be said to substantiate the statement. Like produces like; kind engenders kind. In these aphorisms is justified the dominant mental tendency to account for present objects or occurrences in terms of their antecedents, genetic, historical, or causal. Sometimes this is mere genealogy; sometimes it involves the biological science of genetics; and the relations may be very complex. Such principles as the Mendelian laws and the statistical methods of experimental genetics and biometrics have been gradually bringing these complex relations into an order that may fairly be termed scientific.

The *developmental* and *evolutional* relations, which involve the genetic relations, are no less important in the order of nature.[6] They are more general, and certain developmental relations are inferentially universal.

The *mnemic* relation roots deep in life, in psychologic and in physiologic processes, in the impressibility of tissues, in the persistence of impression, in the retracing of prior "pathways" in the cortex of the brain, and in the formation of concepts and of habits. It is one of the bridges over the gap between the physical and the psychical. Important indeed it therefore is in the order of nature, and especially in that higher range of the *anthropological,* which may be termed *the social order,* involving the psychic, the ethic, and the æsthetic interests and relations.

These generalizations — perhaps so general that the reader may fail to comprehend them — complete our summary of the principles and relations of the order of nature. Henceforth we shall have to treat more specially and more concretely of this order and its extension into the anthropological and social.

[5] In John W. Young's *Lectures on Fundamental Concepts of Algebra and Geometry* there is a very clear and readable statement of the nature of *Variable and Function* (pp. 192–7), which may be compared with the following definition in *Encyclopædia Britannica: "Function:* a variable number, the value of which depends upon the values of one or more other variable numbers."

[6] Among many good books, one by Professor T. H. Morgan, *Evolution and Genetics* (1925), may be mentioned as giving concise and judicious views of the theories of evolution in relation to genetics.

4. DEVELOPMENT AND EVOLUTION.

We perceive development not only in living things but in things "inorganic", which may have some organization. From the inorganic to the organic there is transition in development, and in the inorganic there is a continuity in the sequence of forms and changes. The general theory of evolution rests on these grounds. The organic development of individuals, or ontogeny, is distinguished from the organic evolution, or phylogenetic development of species and genera. This multiplex series of biologic developments is regarded as causally determined and inferentially it is purposive.

From experience we know that things develop; we perceive them changing and growing about us and in ourselves. The series of changes may appear continuous or discontinuous according to the accuracy of our perceptions. The developments evidently have internal as well as external causes, intrinsic tendencies to reproduce units, to multiply increments, to unfold what is inherent, and to adapt structures and forms to environing conditions. This development has evidently arisen from the inorganic and has extended upward thru the biologic into the mental and the social. The marvelous frost-figures on the window-pane, or on the pavement, so like the foliage of moss-plants, of exquisite lace-like tracery, coming out of the chilled moisture of the contiguous air, are these indeed inorganic? They have a kind of organization. What forces then activate their delicate structures, their subtle morphology? And the crystals of massive minerals, with their constant axes and angles, are not these too developmental in both senses, that they *grow* out of a magma while we watch in wonder, and that these actions and tendencies have a long *natural history*. The chemical elements and combinations also, are they not products of developmental processes in the molecular recesses of nature? Chemistry is indeed a science of law and order. Does not this order reach down into those implied developmental processes? Are not the manifold changes of the radioactive substances in evidence? Are not the facts of stereochemistry? Are not all chemical substances and relations in their several ways not only orderly but developmental?

The *general* theory of evolution rests on the inference that physical entities are developmental, tho not just as biological organisms are. To assume that progressive development and evolution commenced only with the origin of life is neither scientific nor philosophic. The paleontological evidences of organic evolution are involved with the geological evidences of inorganic transition and development. The Earth as a whole is evidently the massive product of gradual physical and chemical processes and developmental changes. There are scientific grounds for theorizing on the evolution of the Earth,[7] the planets, and the stars, which have changed and developed, probably in conformity with persistent causes and constant laws, some of which are now known in physics and astrophysics. The universe involves a system of dependent and developmental relations.

The Earth depends upon the Sun for heat and light, for energy and life. If that great source had ever been shut off for any considerable time, life in this planet would have perished in utter desolation. In the rocks there is evidence of accretion and gradual transition from a lifeless era of immense duration. Then at some vague epoch the lifeless there was quickened into the vital. Were those momentous changes effected thru the actions of physical forces alone, or thru other mysterious agencies? Affirmative answers should not be dogmatized, nor indeed should the negatives.

"Yet it is quite impossible to escape from the idea of living things as natural products, for science involves determinism and determinism imposes this very concept. With the increase of our knowledge of organization we see ever more clearly the interdependence of all living things and the harmony between the organism and its environment. This leads us to a conception of the organism as intrinsically a part of nature and so to the idea of nature as a whole."[8]

[7] In a series of lectures entitled *The Evolution of the Earth,* edited by Prof. R. S. Lull and published in 1918, two are most interesting in this connection, the first, "The Origin of the Earth", by Prof. Joseph Barrell, and the second, "The Earth's Changing Surface and Climate", by Prof. Charles Schuchert.

Prof. A. J. Lotka in his *Elements of Physical Biology,* Chapter II, defines evolution in general even more broadly in physical terms: "Evolution is the history of a system undergoing irreversible changes."

[8] Henderson, *The Order of Nature,* pp. 115–16.

Less obscure actions and processes have been inferred from their special effects; some have been evidently continuous, some perhaps catalytic, some apparently discontinuous, some presumably cataclysmic. But somehow amidst these processes there have arisen diverse structures, new forms, and novel combinations. From the physical the chemical have differentiated; from the chemical have developed the vital; from the vital the mental have sublimated; and from the mental have ensued the social elements of life. There has been a gradual but continuous development from the simple, homogeneous, and unorganized to the heterogeneous, complex, and organized structures and systems of nature and life; from differentiated inorganic components and forms to variable, plastic, and adaptable organs and functions, to active, reproductive, responsive, and sentient organisms and systematic organizations.

This progressive development, or *evolution,* has been intricately complex in its causes, its "factors", and its relations, and it has required incalculable duration. But it is evidently coherent, it is on the whole scientifically veritable, and it is inferentially universal. "The Order of Nature is such that an increasing evolution of fitness is possible, there is adaptation in cosmic evolution as a whole — it leads up to intelligent, moral persons, adapted to the intellectual and practical conquest of Nature, adapted to mirror the reason without in the reason within." [9]

The main theory of *organic evolution* is so well verified, and the doctrine is so well known, that we need not outline nor defend it here. It is a safe conclusion, tho the evidence may remain incomplete, and tho some contrary-minded thinkers may still deny its validity. Progressive development pervades the real relations of organic life and growth in conformity with laws now well known or probably ascertainable. These laws are generalizations from cumulative evidence, from well-verified, classified facts. The order of Nature as

[9] J. A. Thomson, *The Bible of Nature,* p. 26.

studied in the biological sciences is largely an order of structural, functional, genetic, developmental, and evolutional relations.

In biological science how is evolution to be defined and distinguished from development? Biological development is growth thru processes of division and differentiation within the cells or organisms, and thru accretion and assimilation of constituents from the environment. It is also an unfolding of inherent properties and genetic tendencies in continuous or successive stages of individual life and growth. It issues in bodies, organs, organisms, and special forms. The causes are primarily intrinsic, but there are also external determinative relations. There is inherent tendency to change and necessary adaptation of the organism to its environment.

The development of individuals is termed *ontogeny*. Genetically this may depend upon a series of past developments in the long course of the *phylogeny* of the genus. Here development is related to evolution.

Evolution is the whole series of developments, regarded causally and historically. It is a complex process, involving intrinsic causes and external determinative relations, and cumulative operation of these in successive and progressive changes and effects. It implies inherent tendencies to change, to vary, to adapt, to revert, to decay, to perish. From the variation there results the multiplicity of forms and characters. Sometimes these have proceeded from successive adaptations to environmental changes and cumulative in a determined direction; and sometimes they may have sprung from the more salient variations termed *mutations*. Among the various forms there is *natural selection*, in several distinct modes, of the more fitly adapted to the environing conditions; and these selected forms persist and develop progressively. In so far as evolutionary progress is realized as cumulative and directional, in nature and in human life, and considering that the determining and organizing forces are evidently immanent in the whole of nature and are per-

sistent, the conclusion is rational that evolution as a cosmic principle or process is purposive.[10] And furthermore the belief is reasonable that this purpose inheres not only in the origin, genesis, and development of the world and life but in life's inheritance, its plasticity and impressibility, its sensibility, mentality, and *mnemic* continuity, its consciousness and its conscience, its mind and its knowledge, its ideal, its purposes, and its destiny.

"However teleological may be the appearance of the products of nature, the teleology of nature itself cannot be scientifically established unless some kind of connection, conceived only as teleological, can be shown to exist among nature's laws.

"When we think of the solar system, the meteorological cycle and the organic cycle, we distinguish that which quite inevitably and directly impresses us as harmonious. Now, as we have seen, it is no longer permissible to doubt that this impression of harmony corresponds to an order in the universe. But it is a false and discredited metaphysical hypothesis which leads to the denial of the order of nature as a subject of scientific research." [11]

5. THE ORDER OF NATURE DEFINED.

The definition epitomizes the preceding survey. Certain manifestations of the order of nature are then dwelt upon. The order, apparent and implied, is realized in real relations, but is also extended conceptually. The reality of the relations ensures a stable basis for scientific classification, while the conceptual components in this imply its relativity and its adaptability.

The way has now been prepared for the following definition. The Order of Nature subsists in constant relations between natural objects, classes, or kinds, and moreover in classes of those classes and of those relations, comprising the relations of recurrence, correlation, dependence (or causation), coherence, conformity, function, genesis, development, and organization. By extension of the order of nature to the anthropologic it may be brought to comprise the psychic, the social, the ethical, and the æsthetic.

The order of nature is manifest in the revolving firmament of stars, in the orbital motions of the planets, whose wander-

[10] Henderson, *Op. cit.*, pp. 117, 118.
[11] *Op. cit.*, p. 118.

ings are but apparent. Observers in ancient times, watching those recurrent movements, in paths so deviously retraced, as tho avoiding too strict restraint and perpetual monotony, may well have imagined that those vibrant circles were musically interwoven with unheard harmonies of celestial spheres.

It is the order of nature that dominates the return of the seasons, that conducts the bright procession of the spring flowers and autumn fruits. How constantly the apple-trees bloom just in advance of the lilacs! How hesitantly the violets in the moist woodlands wait in the gradual procession of April till the pale anemones have waned in their peerless loveliness! How eagerly in early June the glad butterflies, so loved by the children, hasten to precede the daisies, which soon will be woven in their garlands! It is the order of nature that appears in the invariable five petals of *potentilla* and in its *cinquefoil* leaves; and in the four-fold, fancied cross-like corolla of the *cruciferæ;* and in the various forms of wing and keel and lip in the papilionaceous flowers and the *labiatæ;* and in the wonderfully appropriate adaptations of the floral organs of the orchids to cross-fertilization by the honey-seeking butterflies and moths.

In the botanic sphere it is no mystic harmony that chimes in the numbers three, four, five, and seven, but therein are real, tho unrevealed, relations of deep scientific significance, implying inherent infinitesimal forces as determining morphological characters. Morphology is marvelously endowed with a hundred intrinsic symmetries and conformities. What makes the leaves of the grape-vine or the currant-bush so persistently alike? Why does the winged seed of the maple come true to its kind? What keeps the beetle from generating the beaver? What law prevents the mammal from generating the bird? It is the order of nature that rules here; and even in the selective and adaptive variations of form and function that have resulted in the countless diversities of natural kinds there is coherence in developmental relations and conformity to genetic law.

How regularly the drop forms at the tiny leak, trembles just an equal instant, and then falls off, as if to measure the minutes? There is a balance of forces in that, and *the rhythm of nature.* In the rainbow we see but the combined refractions from myriads of showering rain-drops, each of countless equal components, of many imperceptible gradations in angle and correlative color. The haloes around the sun and moon are also results of composite conformity to physical laws; and their angular distances are constant.

Thru all these natural phenomena the order of nature prevails.

"Everywhere the universe is a cosmos and not a chaos: 'Order is heaven's first law'. Order is seen in the whole stellar universe, the solar system, the earth; it is strikingly evident in the phenomena of physics and chemistry; but the order and fitness of nature reach a climax in the living world." This goes on, rising in eloquence: ". . . think of the fitness of every organ to its particular use, and then consider the peculiar fitness with which all these organs and all their innumerable parts are coördinated into one harmonious whole. Viewed in this light, 'What a piece of work is a man' or any other organism!" [12]

Some relations are simple and evident, some are too complex for analysis or too minute for discernment; some are statistically approximate, some are mathematically expressible; some we admire as the marvels of scientific discovery; some we love as *the beauties of nature.* In all these scientific and æsthetic aspects there inhere the pervading consistency and constancy, regularity, symmetry, and rhythm, in a word, the order of nature. "But that the world is a realization in time and space of some such ideal as science has built up — an ideal unity of order, beauty, and meaning — this is the growing conviction upon which the particular sciences, from their different points of view, and by their different methods, have been converging." [13]

It is in real relations that the order of nature is realized. The correlative concept may, however, extend to comprise

[12] Conklin, *The Direction of Human Evolution,* pp. 218, 219–20.
[13] Prof. G. T. Ladd, Science, Feb. 21, 1913, p. 289.

assimilable conceptual relations, for such is the nature of concept development and such the method of theoretical science. But, if these conceptual extensions are not later deductively verified by consistent empirical evidence, they will not be retained within the true concept.

As a basis for scientific classification the order of nature may therefore be used in some extended form comprising conceptual relations, especially for the anthropological and social sciences. The more the conceptual is admitted therein, however, the more plastic but also the more impermanent the classification will prove to be. Stability in such classification depends accordingly on the validity and permanence of scientific principles and on the verification of scientific relations, in other words, on the reality of the order of nature.

PART III

THE SYSTEM OF THE SCIENCES

Thus we see that the ordering of facts and their relationships in each individual science is the first and most important function in its development.

We are therefore confronted by the task of subjecting the whole range of science to the same organizing and systematizing process which has been carried out so successfully in single sciences, to the advantage of society as a whole.

. . . a systematic arrangement of all conceivable and all possible sciences, in the order of narrowing range and increasing content of the ideas, . . .

The more of general ideas and laws enter as regular component parts into all higher or more special sciences.

WILHELM OSTWALD, *The System of the Sciences.*

Il importe au progrès de chaque science que ses méthodes soient bien définies, ses problèmes nettement posés, et pour cela il faut se rendre compte de ses relations avec toutes les autres, et de ce qu'on peut appeler, par analogie, sa *position systématique.*

EDMOND GOBLOT, *Essai sur la classification des sciences.*

CHAPTER XI

SCIENCE AND THE SCIENCES.

1. THE DEFINITION AND THE SCOPE OF SCIENCE.

Science is to be distinguished, not separated, from other knowledge. Science is defined, and the several terms of the definition are then discussed; and some illustrations are given. The scope and the limitations of science are indicated, and its difference from philosophy and from history. Scientific principles, theories, and laws are distinguished. The terms *abstract, concrete, exact, descriptive, applied,* etc., are relative, not distinctive, and are inappropriate for classification.

Organized knowledge is composite of all kinds of knowledge, not only scientific and historical, but also common and empirical and even ethical and æsthetic knowledge. Thru accretion of data, thru synthesis of coherent components, and thru the interrelation of subjects, there develops the system or organization of knowledge, to which may be ascribed "the unity of knowledge". Where there are such interrelations there can be no complete separation. Science, then, is to be distinguished, not dissevered, from other kinds of knowledge, empirical, derivative, and rational. But how is science to be distinguished?

In proposing to define science one can hardly do better than to combine the terms used by a succession of eminent scientists who have written on the scope of science: Aristotle, Spencer, Huxley, Wundt, Lester Ward, Pearson, Ostwald, Poincaré, Picard, Hobhouse, J. A. Thomson, Frederick Barry, and others. Science is at once empirical and rational; it is verified, synthesized, organized, systematized knowledge. From accumulated and tested empirical data and from simple concepts and perceptual relations it proceeds methodically to generalizations and abstract conceptions, and to synthesis of more complex concepts and conceptual relations. Its methods comprise observation and analysis, abstraction,

definition, and classification, measurement, testing, and experimentation, statistics, tabulation, and formulation, correlation, interpolation, and integration, reduction, induction, and deduction. It thus attains to hypotheses, theories, laws, and principles, predictions, diagnoses, verifications, and explications. It is applicable, at least in some measure, in the various arts, technologies, and economies of human life, and is moreover highly valuable intellectually. It is purposed ultimately to attain to a comprehension of reality.

The foregoing may be digested into the following comprehensive statement: Science is verified and organized knowledge, rationally and methodically proceeding from empirical and experimental data, simple concepts, and perceptual relations to generalizations, theories, laws, principles, and explications, and to more comprehensive conceptions and conceptual systems. Science tends to, and under certain conditions attains to, precision and to prediction. It is applicable in arts, technologies, and economies, and is moreover valuable intellectually and educationally.

Reduced from this comprehensive statement, the following is proposed as an adequate definition: Science is verified and organized knowledge, analytic and synthetic, rationally and methodically proceeding from experiential data and perceptual relations to generalizations, theories, laws, and principles, and to conceptual systems.

For a concise definition the above may be further reduced to its essential terms as follows: *Science is verified and organized knowledge, experiential, rational, methodic, proceeding to generalizations, theories, and conceptual systems.*

Science is grounded in *experiential* data; its concepts have been developed by abstraction from coherent empirical elements.[1] Science is *rational* not only in its methods but also

[1] The term *empirical* unfortunately has two different meanings. It is here used in the broader sense, current in science and philosophy, comprising the data of experience, observation, and experiment. A very well written justification of this kind of empiricism may be read in Barry's *Scientific Habit of Thought,* pp. 49–53. In the other sense, for knowledge drawn from un-

in its conceptual synthesis; in it the empirical and rational are combined. Its perceptions are extended by means of its marvelous instruments inwards to the ultramicroscopic and outwards to the remote stellar systems; analytically it attains to the infinitesimal and synthetically it comprehends the cosmic. The things of common knowledge science treats as existent in and constituted of ulterior realities, and so discusses them in terms of the ulterior. Scientific technology brings into our streets and our homes, our factories and our ships, in commonplace conveniences and serviceable appliances the manifold products of the infinitesimally small and the immeasurably great.

Consider the marvels of the motion pictures and of radio-communication. The common telephone impresses the vibrations of the voice, having hundreds, or even thousands, of oscillations to the second, on the carbon particles in the transmitter, making them vibrate at precisely the same frequencies; and this complex vibration is exactly impressed on the electric currents that are carried by the wire to the receiver, which in turn transmutes these vibrations, reconverting them simultaneously into the sounds of the speaking voice. These sound vibrations in air would move in waves of compression from one to ten feet apart, yet they exactly affect the little diaphragm of the transmitter and the current in the silent wire. Commercial radio-telephony usually employs waves of about two hundred meters length and a million vibrations per second. In transatlantic *radio* the waves are a mile or more in length.

The experiential data of science are *verified* more *methodically* than in common knowledge, which deals with objects of *perception* or *acquaintance* more directly and intuitively, and which therefore is originally personal, but, being common to many persons, tends to cohere in the social mind without be-

scientific *experience,* it is often used in scientific literature and sometimes in philosophic, as in Professor Dewey's book, *How We Think,* Chapter XI. The two contrasted kinds of knowledge are, however, found to be closely interwoven.

ing verified methodically.[2] But scientific data are analyzed, classified, measured, and tested, and are compared with like and recurrent data in a coherent body of experience individual and social. In brief, scientific knowledge is verified and organized.

Method, not content, and especially *classification,* make science, according to Pearson. "It is not the facts themselves which form science, but the method in which they are dealt with." And on another page: "The classification of facts and the formation of absolute judgments upon the basis of this classification — judgments independent of the idiosyncracies of the individual mind — essentially sum up the aim and method of modern science." [3]

The term *impersonal,* sometimes applied to scientific knowledge, should be qualified in view of the fact that a scientific investigation and the resulting theory usually develop, at least to a certain stage, in the mind of an individual scientist. In so far as he is a competent scientist that knowledge or thought is scientific, tho for the time it is personal. Later, when articulated with the knowledge and thought of other scientists, it may become more adequately tested, criticised, corroborated, and verified; and it would then become cooperative, social, or super-personal. Of course the investigation, the theory, the verification, all depend upon preëxisting coöperative contributions and methods, but their development depends especially on new contributions, which at least for a time are personal.[4] The verification of the data and relations and the validity of the generalizations and laws depend logically on the constancy of natural law but intellectually on a *consensus* of minds accepting those truths and

[2] The relation of science to common-sense knowledge is the subject of interesting paragraphs in Edman's *Human Traits,* pp. 382–7. The relation of common-sense thinking to scientific thought is very well stated in Professor Barry's book, cited before, pp. 31–3, and the process of imagination, conception, hypothesis, and verification, in pp. 103–9.

[3] *Grammar of Science,* Chapter I, § 5 and § 2.

[4] *Cf.* F. H. Hankins in Barnes' *History and Prospects of the Social Sciences,* p. 257.

theories. So science is on the whole a synthetic, coherent, coöperative, social product.

"When one turns to the magnificent edifice of the physical sciences, and sees how it was reared; what thousands of disinterested moral lives of men lie buried in its mere foundations; what patience and postponement, what choking down of preference, what submission to the icy laws of outer fact were wrought into its very stones and mortar; how absolutely impersonal it stands in its vast augustness — then how besotted and contemptible seems every little sentimentalist who comes blowing his voluntary smoke-wreaths, and pretending to decide things from out of his private dream." [5]

More coherent and synthetic than common knowledge and more methodically verified and organized,[6] science proceeds to generalizations, abstractions, theories, and conceptual systems, confining its scope, however, to realities and to concepts resting on experiential data. Of the conceptual the scientific conscience is professedly critical, — aside from mathematics; but of the metaphysical and transcendent scientific thought is professionally censorious. Abstract conceptions that by rational processes are reared too remote from empirical bases, with regard rather to ethical, religious, and æsthetic implications, Science assigns to Philosophy. Whether such are really valid or intellectually valuable depends upon the verity of the postulates from which the reasoning commences, and upon the verifiability of the conceived or assumed relations which are therein comprehended. True philosophy, however, as a superstructure resting on the foundations of common knowledge and science, proceeds to more abstract conceptions, more transcendent relations, and more metaphysical implications. Thus abstraction and generalization, so distinctive of science, are also the very essence of philosophy; and not only in materials but in methods science and philosophy have much in common, and they should be re-

[5] William James, *The Will to Believe.*

[6] Professor Barry shows that verification is a duplex process, "the determination of consistency in thought" and "a consistence . . . of ideas with events" — with facts — "consistency with the rest of our experience in thought" and "in the world of events." *Op. cit.*, pp. 104–5 and 109–10.

garded as complementary, not as opposed. The distinction to be emphasized is that science professes to confine its theories to *valid generalizations* and to conceptions that rest on *verifiable data* and on *veritable* or *real* relations. In brief, its conceptions relate to realities.

Veritability, or *verifiability,* depends upon accessibility for observation and testing, and upon evidence and corroboration. Physically it depends upon constancy of relations and of properties, and on conformity to scientific law. Constant properties and actions in natural objects persist and recur in constant, or in constantly variable relations. The scientist observes the constancy and the conformity, and he may predict the recurrence. The agreement of different observers corroborates the evidence. The relations involved are in some conformities *determinative* or *causal.* The statements of these conformities and relations are termed *scientific laws.* The laws of a social-political state are statements of conformities and obligations *conditionally* enforcible thru social and penal sanctions. The laws of nature, or of science, are *a fortiori* constant, inflexible, and determinate. They are based on valid generalizations and confirmed principles. The laws of men are fiats; the laws of nature are facts.

A *theory* is a generalized statement of determinative relations involved in the relevant phenomena and actions, and it comprises the important relevant principles and laws. It may be either *summarized* or *extended* in description and explication.

Scientific *prediction* and *diagnosis,* which imply classing particular things and deducing that they result from their determinative relations, would be discussed especially in a study of *functional* organization of knowledge; but here these, as well as other applications of science, will be passed merely with the remark that they justify the increasing human interest in the verifications and the classifications of science — the structural organization of knowledge. Prediction is indeed one of the best tests of a theory.

By generalization science is more positively distinguished from *history* than it is from philosophy. History for the most part deals with concrete, or discrete, objects and individuals, with particular events, parallels, movements, tendencies, and developments, as antecedents and consequents, tho it also considers the determinative, or *causal,* relations, or "forces".[7] In so far as these are referable to definite types, or classes, the descriptions tend to become general and scientific; and in so far as these relations, movements, and courses of events may be generalized by abstraction history enters into the sphere of philosophy as the *philosophy of history.* This as an interpretation of the general history of nature, of human nature, and of society, is grounded upon the descriptive, historical, and explanatory sciences of biology, geography, anthropology, ethnology, sociology, and economics. The science of economics attains to a more definite abstractness, tho likewise it is rooted in the descriptive data of economic history.

Science is distinguished from art, or the knowledge of art, as a body of definitions, descriptions, theories, and verifications is distinct from knowledge of the modes of doing or making things, and from skill in such modes, and from appreciation and criticism of the products of such knowledge and skill. The application of science to the arts is, however, highly valuable; and with respect to such applications the sciences and the arts are intricately intertwined.

From the foregoing definitions and discussions it is evident that science cannot be adequately defined in simple terms, much less by a single phrase, as is often done. *System* is, according to Hobhouse, the most significant term.

"The best single term for describing the general character of science as opposed to common sense is System. Science works the data of experience into a whole of interconnected facts. . . . Common sense carries interconnection as far as is necessary for the

[7] Several relevant questions are well discussed by Prof. Carl Stumpf in his discourse, *Zur Einteilung der Wissenschaften,* in *Abhandlungen d. K. Preuss. Akademie d. Wissenschaften,* 1906, *Philosophische-Histor. Classe,* V, pp. 55–9.

purpose in hand. But a new step is taken when the purpose in hand is that of making interconnection complete, and this is the step taken when we begin to investigate a subject for the sake of understanding it through and through. In science system becomes the explicit purpose.

"Science is systematic in the first place because it seeks to be complete. It takes a certain subject-matter and examines it not from the point of view of some practical or imaginative interest, but for the sake of understanding its essential nature as exhibited in all its developments.

"The preparatory work of such a system is that of classification, the final work, that of Explanation. As the highest of the "systematic forms", Explanation exhibits the fact explained not merely as dependent on another fact, but as necessarily occupying its assigned place in a system of connected facts . . . the tendency of science seems always to be to a systematization of thought which shall not be merely a connection of some one element with some other, but rather the reference of all elements to a whole into the plan of which they fit." [8]

The *scope of science* has been the subject of much debate. Especially there has been question whether certain studies, for instance, sociology, history, or economics, may properly be called sciences. Pearson maintained that "the material of science is coëxtensive with the whole physical universe, not only that universe as it now exists, but with its past history and the past history of all life therein." [9]

According to this view, we should conclude that studies, be they physical, technological, economic, ethical, historical, or philosophic, are scientific in so far, and only in so far, as their subject-matter is verified, treated with scientific method, generalized and organized. This conclusion is very important in connection with the principle of the *gradation of the sciences by speciality,* of which the next chapter will treat.

Many writers have argued that only certain limited fields of research are properly scientific — those within which generalizations, theories, and laws are attainable and verifiable.[10]

[8] *Mind in Evolution,* The Macmillan Co., New York, 1901, pp. 329–31.

[9] *Grammar of Science,* Chapter I, § 5.

[10] Prof. E. W. Hobson in his Gifford Lectures for 1922–3, published with the title, *The Domain of Natural Science,* critically shows the limitations of the natural sciences and reasonably affirms the autonomy of theological thought.

No science worthy of the name falls short of some theory or explication of the facts it comprehends. Without theory, studies that deal descriptively, analytically, statistically, or historically with the concrete, the individual, the occasional, and the probable, are not entitled to be dignified as sciences. But indeed there are few studies that have not progressed so far as to permit of some generalizations and some theory. Generalization is the correlate of abstraction; and theory is the generalized statement of relations, actions, or solutions.

On the other hand no science is entirely theoretical or abstract, without any empirical or descriptive material. The "abstract" sciences, dealing especially with conceptual relations, can be realized only in concrete things in particular relations. Even logic and mathematics have empirical grounding [11] and descriptive particulars, and in various applications are *mixed* with physical and statistical facts.

There is no better justification for the distinctions between *pure* and *applied* science and between *exact,* or *precise,* and *descriptive,* or *synoptic,* sciences. The term *pure* implies abstraction from the concrete; but the application of science to concrete objects, or classes of such, involves principles and methods drawn from several "pure" sciences. Thus astronomy for the complete study of celestial bodies employs mathematics, physics, and chemistry. Even in studies that are for the most part descriptive and inexact some groups of data may be *exactly* determined and there may be *precise* formulations and even predictions.[12] In all sciences description and theory, problem and method are intertwined. The terms

[11] "In Wahrheit beruht aber der Unterschied der mathematischen und der empirischen Wissenschaften überall darauf, dass sich jene nicht auf die Gegenstände and Vorgänge der Natur selbst, sondern auf die formalen Abstractionen beziehen, zu denen ein beliebiger Erfahungsinhalt Anlass geben kann." — Wundt, *Ueber die Eintheilung der Wissenschaften,* in his *Philosophische Studien,* Band 5, p. 20.

[12] Conversely, as Prof. Stumpf showed (*Op. cit.,* pp. 63–4), the descriptive natural sciences, treating of natural kinds and their structures and functions as reducible to generalizations and laws, deal also with individuals and their actual functionings or behavior; and even the physical sciences often consider concrete or particular phenomena or kinds of bodies.

pure and *applied, exact, precise,* and *descriptive* are relative and not distinctive.

Abstractness has falsely been made the basis of a primary division of the sciences into the *abstract* and the *concrete,* according to Spencer, Comte, Bain, and others. Spencer distinguished also as intermediary the group he termed *abstract-concrete.* Clifford, Pearson, and others have contradistinguished the *exact,* or *precise,* sciences from the *descriptive,* or *synoptic,* sciences. These terms and divisions will be discussed in Chapter XIII and again in Chapter XVIII. It suffices here to state that all of this group of terms, — abstract, general, theoretical, pure, exact, precise, special, concrete, descriptive, synoptic, and applied, — are relative, are applicable only in partial views, and as a basis for division are not distinctive and are inappropriate.

2. SPECIAL SCIENCES.

Sciences, having developed with regard to special concepts, interests, and methods, are special with respect to these. Where they have common ground, they treat the materials in their different ways. The natural sciences are more definite than the anthropological and social sciences.

In view of the relativity of knowledge and the interrelations of interests, it is only in a restricted sense that we may speak of special studies as distinct. A scalar series of sciences may be likened to a ladder overgrown with vines, thus combining in the unity of knowledge. Yet the "special" sciences began in diverse special interests. In those beginnings it was plain that the special objects, or groups of objects, or classes of phenomena, were so different in their nature and their relations that they must be studied differently. Herein lay the roots of special methods. The data reduce to distinct descriptions, classifications, and generalizations, and the actions and relations involved are comprehended under distinct concepts and theories, principles and laws. Thus from the rudiments and from *nuclei* of inquiry or research, the several sciences have grown up as *distinct,* centered about their main concepts, interests, and problems, and have mean-

while developed special methods that are more or less distinctive. These distinct sciences exist together somewhat as a community, in which the members maintain sufficient individuality, each keeping his own name, having his own problems, and thinking his own thoughts. A science is *special* in the sense that it is *centered about special concepts, interests, and problems.* Each science has in a similar sense individuality.[13]

As was said at the end of the preceding section, the term *special sciences* is relative, as is also the term *general sciences.* The former term is frequently met in philosophical and in other literature in rather loose usage for any kind of distinct science, but more significantly for those generalized sciences also often termed *general* or *fundamental,* as distinguished from minor or more special branches that are derivative from them. Biology is one of the "special" sciences, the philosopher would say. "Do you mean general biology?" the naturalist would return. The biologist and the library classifier know that there is also General Physiology, or the general science of physiology. One sees that these terms are relative.

Tho the several sciences have thus remained sufficiently distinct in scope and individual in character, they have worked some fields in common, and have made some occasional forays into neighbor fields, not always the closest. Rival claims may still be heard, and certain boundaries have therefore been staked out so as to forestall contention. There are, however, many ways of transit and communciation.[14] The special sciences are not only interrelated but interdependent. As Herbert Spencer remarked at the end of an interesting passage, "We find that, to make a single good observation in the purest of the natural sciences requires the combined aid of half a dozen other sciences." [15]

A special science may in some stage of its development extend its

[13] ". . . a science receives its distinctive characteristics quite as much from the point of view from which it approaches its facts, and from the purposes and guiding conceptions which dominate it, as from the nature of the groups of facts which make up its material content; . . ." — Jastrow in Baldwin's *Dictionary of Philosophy,* v. 1, p. 53.

[14] ". . . en réalité, toutes les sciences se ramifient, s'entr'aident; s'il est nécessaire de grouper les connaissances humaines en grandes catégories, pour mettre un peu d'ordre et de méthode dans ce qui serait autrement un chaos, il y aurait imprudence à méconnaître qu'aux limites de chacunes d'elles il existe, non pas une ligne de démarcation nettement et rigoureusement tracée, mais au contraire une sorte de zone frontière sur laquelle plusieurs sciences diverses peuvent revendiquer des droits égaux." — Laisant, *La Mathématique,* Paris, 1898, p. 24.

[15] "Genesis of Science", in *Essays,* v. 2, pp. 66–7.

scope and draw materials from fields already appropriated by sister sciences, and it may employ methods in common with others, yet, while making use of those concepts, principles, and methods, it treats them in its special way, for its special purposes, from its special viewpoint or interest. Ethnology and Sociology, also Anthropology and Sociology, work certain fields in common, but their several interests and purposes are distinct. Ethnology is a comparative study of ethnic materials, purposing to derive general ideas of racial and cultural developments. Sociology, a much broader study, is rooted in the same ethnographic materials but studies the anthropologic and ethnic developments as related to social mentality, conduct, relations, and organization. Anthropology, a still broader science, comprises the whole of human nature, but studies more especially the anatomical and psychological *differences* between types of mankind, with intent to understand and in some measure to modify human nature in its racial, biological, and social-economic relations. Folk-lore is a descriptive science working beside Ethnography but contributing less to ethnology than to anthropological psychology and to the origins of primitive imagination, religion, and traditional literature.[16]

Such complicated distinctions indeed show how difficult it is to define some of the descriptive sciences; but those that deal with physical actions and relations and with natural kinds of objects, especially those termed classificatory, are, even while interdependent, inherently more distinct.

The individualities of the several sciences, the central concepts, interests, or purposes, in respect to which they are distinct or special, and their relations to one another will be discussed in subsequent chapters.

3. BRANCHES AND SUB-SCIENCES.

The several sciences are complex, as Biology exemplifies. Fundamental sciences are distinguished from derivative sciences, sub-sciences, branches, and applications. The relativity of the terms, however, is averred. The distinctions are drawn for convenience.

If all sciences were simple, pure and perfect, the problem of classifying them would be comparatively easy. But sciences are not simple, nor "pure", nor perfect; they are more or less complex in synthesis; they are "mixed" with their own various applications, and with materials appropriate also to other sciences; and they are so imperfect that ap-

[16] The Folk-Lore Society of London published a book on *Primitive Paternity*, a study by E. S. Hartland of myths and customs in relation to the history of the human family, the material of which may be regarded as belonging to any of the four sciences named above.

proach to completion might indeed change their structural classifications. Biology, for instance, treats not simply of the anatomic structures of organisms but of their complicated functions. Furthermore it considers not only the existent forms but the whole *phylogenetic* series both historically and comparatively, and with regard to adaptation of varying structures to changing functions in changing environments. There are diverse applications of biological science to the study and control of human health and disease, to the care, culture, and conservation of plants and animals, to the elucidation of mental phenomena in animal behavior and in human, and to many other practical and economic interests. For the outlook in science at present is toward utility and economy no less than to theory and to explication. The general, or *fundamental,* science of Biology is thus a basis of generalizations, principles, and theories, from which extend the several *branches,* Anatomy and Morphology, Physiology and Ecology, Ontogeny and Phylogeny, besides under Morphology the special sub-sciences Botany and Zoölogy. Under each of these and under Ecology there are economic branches. This outlines too simply the manifold complications, which will be considered more adequately in a subsequent chapter.[17] In this wide range of studies the neighbor sciences of Physics and Chemistry, and even the methods of mathematics and statistics are drawn upon. The historical study of biological forms in the higher stages extends into the history of humanity. Such complications of branches and sub-sciences are hardly reducible to cross-classifications and sometimes even exceed the analogy of three-dimensional ramification.

The term *sub-science* has been introduced here to designate such broad studies as Botany, Zoölogy, and Mechanics, which are often called sciences or special sciences, and which may themselves have several distinct branches and applications yet are less general and comprehensive than the sciences termed *fundamental,* of which Biology and Physics are examples. Biology is the science of life in

[17] Chapter XIV, § 5.

general, of principles and generalizations; Botany and Zoölogy are branches, or sub-sciences, dealing with approximately definite ranges of classes; and they are descriptive of the concrete and special rather than the theoretical or general. Yet all thru these distinctions the relativity of the terms and definitions must be borne in mind: sciences, special sciences, sub-sciences, branches of sciences, all are relative terms. From the point of view of the unity of science, Biology is but a branch of science. With regard to speciality Zoölogy is a special science, and so may Mechanics be regarded. The distinctions we attempt to set up here are for convenience. We think it convenient to distinguish Biology as a *fundamental science,* Morphology and Physiology as *branches* of it, Botany as a *sub-science,* and Plant Physiology and Economic Botany as branches of this sub-science. The need for these distinctions will become more evident in later discussions.

4. COMPOSITE SCIENCES AND COMPLEXITIES OF SCIENCE.

Studies derivative from several sciences we term composite. Anthropology and Geography are examples. Four kinds of complexity in science are distinguished. Some special studies are termed *monographic.* Is Bacteriology a science or a sub-science? Is Crystallography? Is Meteorology? Astronomy and Geology are composite: are they special sciences?

To studies such as geography and anthropology, which are drawn from a wide range of observation and which comprise materials, mainly descriptive, that are likely to be treated otherwise in other sciences, some writers refuse the name of science, holding that they lack unity of interest and content such as the special sciences are supposed to possess, — that they lack what is termed the individuality of such sciences. Some of their content, however, whether descriptive or theoretic, is admittedly scientific, and they employ methods undeniably scientific. Yet their lack of definiteness precludes their being regarded as special sciences or groups of special sciences. Geography is not a group of special sciences; the same may be said of Anthropology. They are rather groups, or composites, of certain scientific studies, of which some are branches of other sciences, or are sub-sciences. The term *composite science* is indeed appropriate to such composites.

Geography comprises a mathematical branch (Geodesy and Cartography, a physical branch, an astronomical branch, a geological branch (Physiography); its branch Geognosy comprises descriptive parts of Mineralogy and may also be regarded as belonging to Geology; its branches Meteorology and Oceanography comprise applications of Physics; from Botany, Zoölogy, and Anthropology it derives branches that belong equally to those sciences; and it is usually studied as ancillary to historical and economic science.

Similary, Anthropology in the broad sense is composite of special branches of Zoölogy, Physiology,, Psychology, Ethnology, Folklore, Linguistics, Geography, Archeology, History, Sociology, Technology, and Economics. This composite science is, however, to be distinguished from the group of sciences and sub-sciences often termed the *Anthropological Sciences,* which comprises not merely branches of, but the entire sciences of, Anthropology, Psychology, Sociology, History, Economics, and Philology, besides others. Anthropology as a general, or central, or composite science comprises the study of man's nature as a whole, while those special sciences have their several distinct scopes, purposes, and methods. These matters will appear more clearly in the divisions and definitions discussed in Chapters XIV and XV.

Complexity of sciences in ramification was briefly considered in the preceding section. Sciences are moreover all complex of descriptive and theoretical, analytical and synthetical, real and conceptual data and statements. But this kind of synthetic complexity is quite different from that of ramification and from that of the composite sciences. It differs less from a fourth kind of complexity to be considered. The more special the conceptual contents of a science, the more complex it is in analysis, in definition, in relations, and in methods; and, conversely, complexity implies speciality, according to Comte, Spencer, Lester Ward, and others. "The more complex sciences grow out of the simpler ones by a process of differentiation. The more general phenomena of the simpler sciences are elaborated into more complex forms." [18] In this view Physics is regarded as a simpler science than Chemistry, and Biology as more complex, and so on. It may be remarked that Physics is certainly not simple. It may also be argued that, if we knew more of life and could generalize biological principles better, the science of Biology might prove to be no more complex than Physics. It is needless to discuss this question here. The writer does not make much of any argument from simplicity, tho he admits the statement that *complexity* is in some respects correlative to *speciality*. This analytical complexity in *conceptual content* is, we repeat, different from *synthetic* complexity in statement, and again from complexity in *ramification* and in interrelations with other sciences.

[18] Ward's *Pure Sociology,* The Macmillan Co., New York, 2nd ed., 1907, p. 68.

So science is complex in four senses. These four kinds of complexity are distinguished yet are more or less implicated and even correlative. In so far as a science is complex in content, the synthesis of its material becomes more complex, and also its statement, and its branches become more complicated in their relations. The term *complex science* we need not use more distinctively.

Contrasted with the complicated and the composite are the sciences that are comparatively *unitary*, for instance, Psychology and Economics. Yet even these synthesize complex data and complicated relations drawn from other sciences. Economics reaches into Biology, Psychology, Sociology, History, Political Science, Geography, and Technology, and makes use not only of statistical but of mathematical methods. Yet the interest centers definitely about problems and principles that are distinctively economic.

Some studies are specific and unitary in scope but composite in subject-matter and complex in method. Photography, for instance, is more specific than a science, while it draws from several sciences, Physics, Chemistry, and Psychology, as well as from Æsthetics. Such special sub-sciences are sometimes termed *monographic*. This term is properly applied to studies that purpose to comprise the whole of some specialty in a field of science, art, life, or thought, sometimes a particular species or variety, or group.

Bacteriology is neither so special nor so composite as to be brought under the definition of monograph. It differs both from a monographic study of *Bacteria* and from a branch of descriptive cryptogamic botany in that it comprises a supplementary portion on pathogenic organisms that are not bacterial but protozoan. This merges into the new sub-science, Parasitology. As thus qualifiedly centralized in scope and definite in purposes, Bacteriology seems entitled to the rank of special science, and it is usually so regarded by its professors. Yet for the main part it is but a branch, or sub-science, of Botany.

Is Physiology then to be regarded as a special science or as a branch of Biology? It lacks the definiteness of a special science; and it is inherently inseparable from morphology; so we regard it as a branch of Biology.

This question of when a science is not a science should not be laid aside until we have mentioned certain peculiar composites. Mineralogy is, strictly speaking, a sub-science of Chemistry. At the same time it is a branch of Geognosy and ancillary to Geology and to Petrology. Crystallography, the preliminary branch of Mineralogy, is also a branch of Physical Chemistry and is closely related to the physics of matter; it is also closely related to Geometry and to certain developments of mathematics. Is it to be regarded as a branch of the sub-science Mineralogy, or as a branch of Physical Chemistry, or as a special science? This question will be answered in classifying the Physical Sciences.

Secondly, Meteorology comprises so wide a range of phenomena and moreover applies so much method and system that it seems better entitled to be named as a science, tho it may also be regarded (as it originally was) as a branch of Physical Geography. On the theoretical side it is indeed physical. It is on the observational side that it is geographic — and in its human interests. Its relation to Anthropogeography is important as regards both weather and climate. As a science, however, it is comparatively new, for, tho men have from time immemorial been subject to the vagaries of atmospheric conditions, it is only during the last three quarters of a century that the data have been systematically observed and methodically studied. And even now, altho good progress has been made in theory and in prediction, the science is far from being positive and still farther from being applicable to control the atmospheric conditions and occurrences it studies to foretell.

Thirdly, is Astronomy a special science or a composite? Astronomy, depending on mathematics, on physics, and on chemistry as more general sciences, is unified by its interest in the cosmic bodies. The same question applies to Geology, which might be regarded as a composite, and which Edmond Goblot (cited above) declares to be a *monographie*. From considerations laid down in preceding pages it seems more consistent to rank both Astronomy and Geology with the major special sciences, tho not with the *fundamental* sciences.

In conclusion it seems consistent to distinguish *fundamental* sciences from *derivative* sciences, and *sub-sciences* from *branches;* and it is sometimes convenient to distinguish certain sciences as *special* while others are regarded as *general*. *Composite* sciences may well be distinguished from *groups* of special sciences, from derivative sciences, and from the still more specific, monographic composite studies.

5. NEW SCIENCES AND THE PERMANENCE OF SCIENCES.

New sciences have been offshoots from older knowledge. Sometimes new materials are found, sometimes new relations, sometimes new methods; sometimes the new methods precede discovery; sometimes they result from the new materials or relations. Scientific research is developmental and coöperative. Examples of new sciences or branches of science are mentioned. There are possibilities in Psychical Research. The relative permanence of fundamental and even of special sciences is emphasized — and of truly scientific classification.

Does the tree of knowledge give forth new branches? Yes, but seldom from adventitious buds. The so-called "new

sciences" are usually new branches from dormant buds or from older retarded growths, unexpectedly developing; that is to say, they are outgrowths from rudiments of previous knowledge, from facts that were partly known before or even investigated with purpose.

"The logical development of any idea yields new knowledge, or that which becomes new knowledge when its consistence with the rest of experience is established. The mind does not immediately grasp all the significant implications of general facts; and the logical revelation of these is discovery. If the relations thus brought to light have been otherwise demonstrated in advance, then logic has revealed nothing new except the correlation of diverse experiences; but even this is frequently of the highest importance. If they have not been thus demonstrated in advance, then logic has yielded something completely new." [19]

Few new sciences are entirely distinct from those long established. Physical Chemistry, composite of old and of new chemical data studied in newly found physical relations and in relation to established physical principles, has rapidly attained in the past quarter-century a place of prime importance to chemists and also to physicists. Astrophysics had in the preceding quarter-century developed out of the more accurate application of physical and chemical methods (especially spectroscopy and photography) to the data of the older Physical Astronomy. Cytology (the study of the histology, development, and physiology of *cells*) arose from a branch of physiology that had preëxisted since the cellular constitution of tissues had been revealed in 1839 by Theodor Schwann. Embryology, Genetics, and Endocrinology are successive kindred outgrowths from preëxistent biological science. Seismology (the study of earthquakes) has been reared upon earlier foundations in dynamic geology.

New materials found in previously known relations lead to less divergence than *new relations* discovered in old materials. From the former type of study result new classes merely, or minor branches of classification; from the latter

[19] Barry, *The Scientific Habit of Thought,* Columbia Univ. Press, p. 173.

type of study arise new branches of science that are more likely to disturb existing classifications, tho not radically, for studies of new relations are in most cases offshoots from the older sciences.

It is *new methods* that are largely instrumental in developing new science (of new materials and relations) out of the old. The dormant branch may have long waited for the invention of the new method. But the discovery of a new relation or new material sometimes directly stimulates the invention of the requisite new method. "For each new science soon acquires new methods, by reason of the peculiar manifoldness which it has to deal with, and the finding and the introduction of these new methods are easily delayed, and, as a matter of fact, often have been delayed, because scientists could not free themselves soon enough from the old analogy." [20]

There is a higher aspect of scientific development. The discovery of new materials, of new relations, and of new methods may indeed produce new branches of science, but, until the new scientific material is synthesized and systematized, it is not scientific in the full sense; it does not satisfy a proper definition of science; it is not new science. Psychology and Sociology are the fundamental sciences most recently synthesized. How scientific work progresses thru the several stages of its development culminating in synthesis and theory, is interestingly described by Lester Ward in pages from which the following passages are abstracted:

"Every investigator chooses some special line and pushes his researches forward along that line as far as his facilities and his powers will permit. If he is a master, he soon exhausts the resources and appliances of the libraries and laboratories and proceeds to construct a technique of his own for his special purposes. He observes and experiments and records the results. Whenever important results are reached, he publishes them. He not only publishes the results, but he describes his methods. He tells the world not only what he has found, but how he found it.

[20] Ostwald. *Natural Philosophy,* tr. by Seltzer, 1910, p. 140.

"If the results thus announced are at all novel or startling, others working along similar lines immediately take them up, criticise them, and make every effort to disprove them. . . . Part of the results claimed by the first investigator will be disproved or shown to bear a very different interpretation from that given them. Part of them will probably stand the fire and after repeated verification be admitted by all. These represent the permanent advance made in that particular science. But no one investigator can establish anything. Nothing is established until it has passed through this ordeal of general criticism and repeated verification from the most adverse points of view.

"Now, each one of the many workers is doing the same thing as the one here considered, only every one chooses a different line and pushes his researches out in a different direction. Thus a thousand lines of research are projected into the unknown from every field of scientific investigation. There is little or no attempt to coördinate the new facts. . . . Finally the synthetic mind comes forward and performs the work of coördination, to be followed by the text-book writer, who more or less successfully puts the science in the way of social appropriation." [21]

A good example of a new *branch* of science is Radiology. Since radioactivity, surmised by Sir William Crookes two decades before, was discovered by Becquerel and the Curies in the last years of the nineteenth century, the extensive new branch of physical science termed Radiology has marvelously revealed materials and relations, properties and principles that are almost wholly new, and has arisen to the height of a new science, or rather sub-science, of new concepts, new interests, and new methods.

From a dormant branch of Physics formerly called Pneumatics, which comprised such studies as those of sails, windmills, parachutes, balloons, and the pneumatic blast, has no less surprisingly developed the highly theoretical science of Aerodynamics, with its great application to Aviation. The stimulus for this came from the first successes of Langley and the Wright brothers in aërial flight. Once started, progress in aviation was exceedingly rapid. Now it is four miles a minute and six miles high; and it loops the loop and performs stunts beyond the attainment of any but human birds.

[21] *Op. cit.*, pp. 9–10.

Radio-communication has even more wondrously leaped into the fullness of life, — like a pervading genius, the marvel-working creature of man's science. First a decade of Hertzian electric waves, then a decade of Marconi wireless telegraphy, then a biennium of radio-telephony, and then in a year the air is broadcasted with news, with knowledge, with thought, and with music, and — someone may add — with nonsense. Physics has run the gamut of wonders, has realized far beyond what erstwhile seemed the limits of conception. And this new magic remains but a branch of physics.

Psychology, if it had indeed realized the very communication of thought from brain to brain, without expression, would have done no more in proportion to its possibilities. Telepathy (or we might suggest *telemnemy*) would have been so much more worthy of the human mind's capacities and so much more profitable spiritually than the imaginative excitements, diversions, and consolations of Sir Oliver and Sir Arthur, self-convinced of their own illusions of the immaterial fairies, the disembodied spirits, and the revisiting dead. Psychical Research may be dormant, as Pneumatics was, and dreaming in its sleep; but it may have great news for us in the future. It is, however, too early as yet to proclaim it as a new science. The best that we can do is to treat it as an ulterior branch of Psychology and give it a chance to grow.

Despite interrelations, complications, innovations, and even "revolutions", the main structure of the system of science remains stable and persistent. The fundamental sciences themselves may develop, but in their central concepts, interests, and problems they do not change so radically as to assume new relations, acquire new positions, and require new arrangements. The fundamental, the general, and the more important composite, derivative, and special sciences have remained in the same order for nearly a century, and this order seems likely to persist for centuries to come; for it is based on the order of nature, on the very nature of things. And these several sciences are sufficiently distinct

for the purposes of such system and classification. They have been distinctly defined and delimited in numberless scientific discussions, from which a consensus has been established without rational or national disagreements so basic as to disrupt the developing permanent organization of science. "But while the old natural philosophy soon ended in a boundless sea of speculation, the present movement gives promise of permanent results, because it is built upon an extremely broad basis of experience. The laws of energy in the inorganic world and the laws of evolution in the organic world furnish mental instruments for a conceptual elaboration of the material provided by science, instruments capable not only of unifying present knowledge, but also of evoking the knowledge of the future." [22]

"The permanence of these classifications is thus at once demonstrated and explained. They are the result of countless adjustments and readjustments of ideas to facts, over the total range of the unimaginably diversified common experience of ages." ". . . All this means, of course, that it is the way in which we describe our vast complex of compelling relations which changes; and this obviously is because experience is continually in process of elaboration, so that the terms of our description must likewise be continually altered in order to embody, in a persistently consistent scheme of thought, new subtleties and corresponding correlations. The instability of these correlations, meanwhile, is becoming less, and the broad outlines of the scientific system not only more clearly defined, but more persistent. New knowledge continues to modify the outline of our world picture, often in startling ways, but its composition is beginning to take on the appearance of permanence. . . . Meanwhile, however, our knowledge of that which is comprehensible, our knowledge of phenomena — our science, grows; not like a crystalline aggregate, by the precipitation, partial dissolution and redisposition of invariable elements of fact; but like a species of organism, by the continual proliferation, absorption, destruction, regeneration, and readjustment of its elementary parts, in functional activity; and at longer intervals by variation and mutation, approaching perhaps a final stability of form. The analogy is imperfect, but its imagery may serve. Not impossibly, it is something more than an analogy. Scientific knowledge reflects the effort which produces it, an effort born of the struggle for life: it is vital; organized." [23]

[22] Ostwald, *Op. cit.*, Preface. [23] Barry, *Op. cit.*, pp. 102, 158–9.

A systematic, purposive classification of the sciences in consistency with the most important of the real relations of the order of nature and with the most relevant of the conceptual relations of science is accordingly *feasible* and is moreover likely to prove relatively *permanent*.

6. APPLIED SCIENCES.

More general sciences are applied to more special, as regards both principles and methods. The term *applied science* usually means applied to special problems. Science is thus useful or "instrumental". Most sciences are "mixed" with their special applications. Applied sciences are composite, but are distinguished from *composite sciences;* some may be referred to fundamental sciences, but in classification others may be relegated to a *residual* class.

Science may be *applied,* in various senses of the term, to the purposes of life and thought. The principles of a more general science may be applied to generalizations of the data of more special sciences or studies. This implies classing the more specific under the more generic; it implies the process of deduction. The particular, the specified, is compared with the generalized, is referred to the general principle. This may not extend our analytical knowledge of the specific, but it places it in synthetic relation with the conceptual system of science. In this sense all the more general sciences are applicable, at least in parts, to those that are more special; and of these special sciences, or parts, some at least are in this implied sense *applied sciences*. Thus Social Psychology is regarded by Graham Wallas in the second chapter of *The Great Society* as a science of applied psychology, that is, as an applied science in both the senses indicated above.

The general physical principle of the transference and conservation of energy is applied to the specific study of light and thence to the more specific problems of lighting by means of electric energy flowing thru filaments against resistance and therefore heating them to incandescence. The still more specific problem of producing light without heat must be considered deductively in relation to that general principle, and also in relation to the special principle of phosphorescence.

Not only the principles but the *methods* of the more general sciences are applied to the investigation of relations, properties, phenomena, and sequences that are data in the more special sciences; they are applied also to the solution of their problems. Science thus is applicable in a more special sense to *problems;* and it is in this sense that the term *applied science* is commonly used. Some scientists have objected to the use of the term for a distinct science or branch of science. Applicability is implicit in all empirically derived science, and it is explicit in our definition of science.

Science pays back to life what it has borrowed from experience. It arises from interest in the problems of life and thought, and it is finally applied to the solution of those problems; to the elucidation and control of nature and of human nature, and to the prediction of recurrences and consequences. Scientific knowledge becomes *instrumental,* as certain pragmatic philosophers term it. As the French proverb neatly phrases it: "Savior c'est prévoir; prévoir c'est pourvoir."

The chemical knowledge that nitrogen is a constituent of the atmosphere, and the botanical knowledge that nitrogen is nutrient to vegetation, together with the biochemical fact that nitrogen is an element of protoplasm, have indicated the specific problem of extracting the nitrogen from the atmosphere, of producing it economically, and of utilizing the product in commercial fertilizers. This problem has been scientifically solved by the technical fixation of free nitrogen from the atmosphere, and by the production of the bacterial fertilizer called *nitragin,* the bacteria of which, when in the root-tubercles of leguminous plants, fix free nitrogen from the air.

We may say that all sciences are "mixed" with their applications, tho these are not always practical. Problem and theory, principles and methods are mixed in all sciences. In what sense then may we distinctively use the relative term *applied sciences?*

There are certain fields of study or research that are cultivated more in solving practical, technical, or economic problems, are more concerned in applying known data and principles by means of known methods, or methods readily derived from those known, than they are in discovering new data, relations, and principles. They are in Bacon's phrase *fructifera* rather than *lucifera*. (We should, however, bear in mind that fruits need sunlight). It is these sciences and studies that may provisionally and for convenience be termed *applied*. Examples of such are: Mechanical Engineering, Aviation, Ophthalmology, Medical Pathology, and Educational Psychology. These are named in what seems the order in which they are relatively fructiferous and inversely luciferous.

Such applied sciences may depend on the principles and methods of many sciences general and special, and they are thus composite, yet they may be fairly distinct. They are, however, distinguished from *composite sciences*, such as Geology, Astronomy, and Anthropology, in that their main purpose is practical, technical, or economic, rather than intellectual.

In classifying the sciences some of the applied sciences may be subordinated to fundamental or composite sciences, but others are not so simply related and must be relegated to the residual classes of Technology, Industrial Arts, or Useful Arts. These problems will be more especially considered in Chapter XIV, § 10.

CHAPTER XII

GRADATION BY SPECIALITY AND THE CORRELATIVE ORDERS.

1. GENERALIZATION, SPECIALIZATION, GRADATION, AND DEPENDENCE.

For scientific classification the logical principle of subordination of the specific to the generic leads to the principle of *gradation by speciality*, which is reciprocal to Spencer's *gradation in generality*. Generalization is again contrasted with abstraction. Its contrary is specification. There is correlation between generality and simplicity, and between speciality and complexity. The sciences, severally centered about concepts more and more special, may be graded by this speciality. The more special are dependent on the more general, and there is inter-dependence. *Filiation*, or developmental derivation and dependence, will be considered farther on.

For classification that purposes to be scientific as well as practical our problem is to abstract from the manifold inter-relations of the order of nature some dominant relation and order that will prove consistent with the logical order of fundamental sciences and studies, from which the derivative sciences and subordinate studies ramify in a coherent system.

In the summary of the principles of classification at the end of Chapter VIII the seventh principle is stated as follows: To *general,* or generic, classes are subordinated the *specific* and successively the more and more specific and analytic. This principle is very generally applicable. Its application to our problem, its basic relation to the fundamental principle we are seeking for the classification of the sciences and of all knowledge, it is the purpose of the present chapter more particularly to affirm.

This principle is no new discovery; it is as old as logic; it is implied in the logical principles of successive divison, specification, and subordination, formalized in the "tree of Porphyry". Where there is a series of successive dichoto-

mies, with *abscissio infiniti,* the series of resulting classes are graded from the most generic to the most specific.[1]

August Comte in his *Cours de philosophie positive,* in 1830, applied this principle to the classification of the sciences, tho he did not distinguish it by the same term as we use. Most of the thinkers who since have discussed the problem have under whatever terms [2] recognized the principle, and many have adopted it more or less fundamentally in the classifications they have put forth. The classifications that have been based on this principle have agreed in the main, tho there have been points of controversy. We shall not enter into discussion of the controverted points till in Chapter XVIII we come to give an outline of the history of those classifications.

Generalization is a mental process underlying all knowledge beyond that of particulars, from the formation of the simplest or most primitive concepts to the synthesis of the most comprehensive and complex. Generalization is thoroly distinctive of all science and philosophy; it is the most important product of scientific method; it is basic to definition, to classification, to theory, and to scientific law. Abstraction is correlative to generalization, and the two are so closely involved in the same mental process that it is difficult to distinguish them.[3] In generalization the mind brings together, or classes, the concrete, particular, specific, and individual; then from the essentials and the qualities, properties, characters, and relations that are common to all, or general in all, there develop the concept and the general idea. Abstraction is the process of obtaining the *generic* from the

[1] *Cf. supra,* Chapter VIII, pp. 151–2.

[2] Comte used the terms *increasing dependence* and *filiation.* Spencer's terms were *decreasing generality,* and *gradation in generality,* with increasing complexity. Bain employed the terms *generality, abstractness, relative simplicity,* and *mutual dependence.* Lester Ward defended Comte, adopting his term *filiation,* as well as Spencer's idea of diminishing generality and increasing complexity. Ostwald emphasized the term *graded abstraction.* Fiske adopted Spencer's terms, expounding his doctrines.

[3] See Chapter VI, § 1, pp. 121–2. See also Spencer's *Classification of the Sciences,* pp. 79–80 (American ed.). He emphasized, perhaps too much, one aspect of the distinction, but on the next page he qualified this.

specific, particular, and circumstantial, by discarding or neglecting the particulars, or characters, that are *not* essential and *general.* The general idea is the product of generalization and inheres in knowledge, in thought, and in imagination. The product of abstraction is the *concept,* to which perceptions cohere, meanings and judgments refer, and thoughts are linked, to which the general idea is correlative, and from which it recurrently arises. The *general* comprises the recurrent in experience, and is *extensively* distributed in space and in time. Of the *generic* are formed the general classes. The concept, the abstract idea, is the mental correlate that *intensively* comprehends the essentials of the generic and the general.

Specification is the contrary of generalization; it is the process of specifying, of defining the specific from the generic, or general, by differences in characters or in relations, that is, by specifications. Generalization is *synthetic,* or prerequisite to synthesis; specification is *analytic,* or implies analysis.

All these processes are, or may be, progressive,[4] and the term *gradation* is relevant to them and appropriate. There are grades, or degrees, of abstractness, of concreteness, and of complexity; and there may be gradation of the abstract, the concrete, the simple, and the complex. There may likewise be gradation in generality and in speciality.

There is correlation between generality and simplicity, and between speciality and complexity. The more knowledge of specialties and relations a concept or complex or synthesis comprehends, the more complex it becomes. By some psychologists the term *complex* is used, implying this.[5] Synthesis comprehends the complex. Then, conversely, com-

[4] "As we pass from lion to carnivore, from carnivore to mammal, from mammal to vertebrate, each higher class — higher in the sense of being more general — is at the same time more abstract, and the *summum genus* in any system of classification will be the most general and most abstract of all." — Gibson, *Problem of Logic,* p. 88.

[5] This does not refer to the special employment of the term *complex* in the Freudian psychoanalytics. (We had almost written *psychoantics*).

plexity is analyzable, and the description and definition of what is analyzed becomes complex. This is analytical complexity, the complexity of the special. The more general the concept or class, the simpler its definition, tho more abstract. It is in this sense that the general is simple, that generalization produces simplification.

The sciences are centered about distinctive concepts based upon broad generalizations. Physics is the science of matter in general and of the actions of energy. Biology is the science of life, of organic forms and functions. Psychology is the science of the mental. Economics is the science of the relations of human wants and productions. The central, or fundamental, concepts to which the foregoing terms are correlative do not indeed comprise the entire content of the respective sciences, and such definitions are of course incomplete; but they serve to distinguish the several sciences. These are further distinguished by methods more or less intrinsic to the different special materials; and they attain to theories and explanations that tend to be definite and comprehensive. Their professors accordingly regard their scope, or field, as delimited, tho not separate from other studies having kindred interests or working upon common materials. In so far then as the several sciences, general and special, can thus be distinguished, they may be arranged or graded by their generality or speciality.

Gradation by speciality is thus no merely arbitrary basis for classification, but it is a principle essential to the very process. It may be comprehensively defined as *the principle by which the several sciences and studies, distinguished by their conceptual scope and their relations to the real order of nature, are arranged in serial order from the most general to the most special.*

The generalizations and laws of each more general science are true in some measure of all the more special sciences. This applies also to some extent to the *methods* of the more general sciences, tho sometimes conversely the methods of

the more special sciences serve to aid the more general sciences. They may serve to solve their problems. But the laws or truths of the more special sciences rarely apply to the more general sciences or solve their problems. The special sciences, however, supply materials to which the generalizations and laws of the more general sciences are generally applicable, and by which they may be verified. Here are involved the principles of the *dependence* of the special sciences on the general, the *interdependence* of the several sciences, general and special, and *filiation* of the more special sciences in successive *derivation* from and dependence upon the more general, as Comte argued and Lester Ward affirmed.

Spencer, dividing the sciences into three main groups, Abstract, Abstract-concrete, and Concrete, asserted that: "The second and third groups supply subject-matter to the first, and the third supplies subject-matter to the second; but none of the truths which constitute the third group are of any use as solvents of the problems presented by the second group; and none of the truths which the second group formulates can act as solvents of problems contained in the first group." [6]

The same idea is more explicit in the following passage from Ostwald's *Natural Philosophy*.[7] "But not only do all phenomena of physics, including chemistry, occur within the limits of the law of conservation, but until the contrary is proved the law of conservation must also be regarded as operative in all the later sciences, that is, in all the activities of organisms, so that all the phenomena of life must also take place within the limits of the law of conservation. This corresponds to the general fact, which I have emphasized a number of times, that all the laws of a former science find application in all the following sciences, since the latter can only contain concepts which by specialization, that is, by the addition of further characteristics, have sprung from the concepts of the former or more general sciences."

Spencer's argument for the interconnection, or interdependence, of the sciences occupies four of the last pages of his essay on "The Genesis of Science".

Ward in the first part of Chapter V of his *Pure Sociology*,[8] after a judiciously qualified adoption of Comte's idea of *filiation*, said: "The filiation of the sciences is also an order of mutual dependence.

[6] "The Classification of the Sciences," in *Essays*, vol. II, p. 93 (New York, 1896).

[7] *Op. cit.*, p. 136.

[8] Published by The Macmillan Co., New York, 1907.

Just as a child is dependent on its parents, so the complex sciences are dependent upon the general ones. This dependence is specially marked between any one science in the series and the one immediately below it, but in a broader sense all the higher sciences are dependent upon all the lower ones."

The term *gradation by speciality* is preferable to others nearly equivalent, such as *gradation in generality* or *decreasing generality* (Spencer), or graded abstraction (Ostwald), first because the noun *gradation* is more appropriate for the name of a principle, and secondly because the term implies progress from the general to the special, which is the logical order, and thirdly gradation *by* speciality is more consistent with *division* and *classification* than gradation *in* generality, which would imply progress in synthesis and generalization.

2. THE NATURAL ORDER OF THE SCIENCES.

The order of the sciences that is most consistent with the order of nature and the principle of gradation by speciality is at once most logical and most practical, and will prove most permanent. In this the conceptual synthesis is relatively or pragmatically valid. The synthesis becomes more permanent thru progress in the organization of science. The logical and natural order is thus established in the consensus of scientists and philosophers.

The order of nature is grounded in real relations and is in most important respects recognized by scientists and philosophers. Since the principle of gradation by speciality is logically valid, the order of the sciences that most consistently combines these two principles is most likely to prove valid and acceptable to scientists and philosophers, even tho it also contains somewhat of the conceptual and arbitrary; and it is very likely to prove relatively permanent.

"If an orderly classification of a general class of objects is possible, then, however subjective the choice of one's principles of classification may be, there is *something* about the general nature of any such order and system of genera and of species, — something which is the same for all thinkers, and which outlasts private caprices and changing selections of objects and of modes of classification." [9]

[9] Royce, in *Encyclopædia of Philosophy*, v. 1, pp. 72–3.

The conceptual content is correlative to the realities known and thought of. Those realities exist in real relations that are not rendered void by being comprehended in conceptual syntheses. In brief, the conceptual content of science does not falsify the realities that science truly correlates and synthesizes.[10] If science did in any considerable measure misrepresent or pervert reality, it would indeed be invalid in thought and of little value to human life. That anti-intellectualistic negation let us leave to the pessimists. Let us therefore affirm the validity of the scientific, conceptual order of nature, on which human life and thought are so dependent. This may be called a pragmatic truth; but let us rationally maintain it on the cumulative inferences of many facts and arguments adduced in preceding chapters.

Henri Poincaré has so broadly, so clearly, and so impressively stated this solidarity and persistence of the correlative real and conceptual structures that two passages in the French original may be appreciated by the reader.

"Maintenant qu'est-ce que la science? Je l'ai expliqué au § précédent, c'est avant tout une classification, une façon de rapprocher des faits que les apparences séparaient, bien qu'ils fussent liés par quelque parenté naturelle et cachée. La science, en d'autres termes, est un système de relations. Or nous venons de le dire, c'est dans les relations seulement que l'objectivité doit être cherchée; il serait vain de la chercher dans les êtres considérés comme isolés les uns des autres." . . .

"On dira que la science n'est qu'une classification et qu'une classification ne peut être vraie, mais commode. Mais il est vrai qu'elle est commode, il est vrai qu'elle l'est non seulement pour moi, mais pour tous les hommes; il est vrai qu'elle restera commode pour nos descendants; il est vrai enfin que cela ne peut pas être par hasard." [11]

But many who accept the present truth of the natural, or logical, order of the sciences deny its durability. Science must admit new and modified concepts and new relations, and these are sometimes radical and result in new classifications. While this statement is true and has been granted again and

[10] For the question whether synthesis is as valid as analysis compare Chapter IX, p. 167.

[11] Poincaré, *La Valeur de la Science,* pp. 265 and 271.

again in considering the principles of relativity and adaptability of classes and classifications, its application to our problem should be qualified by two great principles that admittedly countervail its negative implications, — the principles of development and organization.

When science was inchoate in the minds of philosophers, a new thought, a new view, did indeed change the aspect of the features that were being molded and re-molded. When physics was but natural philosophy and natural philosophy was but metaphysics, when social science was but philosophy of mankind and ethics but moral philosophy, there was little permanence in theories and less organization in systems. But those plastic periods of youth are past, and science has attained to the fullness of manhood, evincing the progress not only of discovery and theory but also of organization. Immense systems of facts and relations have become organized. The fundamental bases of this establishment have for the most part long remained unchanged and seem likely to be relatively permanent. "In these concepts there appears something fixed, immutable, universally valid; something which exerts a compelling influence, and excludes what is arbitrary." [12]

The affirmation of the reality of the order of nature with regard to the classification of the sciences was made with especial clearness by Lester Ward, a scientist-philosopher of extraordinary intellectual comprehension. "The serial order of the sciences is not an optional arrangement in which different authors may differ at will. It is the order of nature, and if all authors do not agree it is because they have not yet fully discovered the true order. . . . What all right-minded persons want is to discover the true order of nature and the natural arrangement of the sciences." [13]

This knowledge of realities, this methodical study of real classes in their real relations, this conceptual synthesis of

[12] Eucken, *Problem of Human Life*, N. Y., 1910, p. 15.
[13] Ward, *Pure Sociology*, Macmillan, New York, 2nd ed. 1907, p. 70.

these in the natural sciences and the mental and social sciences, and in the arts and technologies, — this great system of studies tends to become rationally and durably organized; despite the kinematical relativitists and the psychical researchers, despite the mathematical conceptualists and the anti-scientific intuitionists, it tends to become the logical and pedagogical order established by the consensus of scientists, philosophers, and educators, and *relatively permanent* because largely, tho not completely, *developed* and because grounded in *the natural order of the sciences.*

3. THE DEVELOPMENTAL ORDER IN RELATION TO THE LOGICAL ORDER.

The question whether the logical order is the developmental order has been a subject of controversy. The several orders are here distinguished. The developmental order is related to the logical as the historical stages are to the present. All sciences have elementary stages, old sciences in the past, and new sciences in the present. There is truth on both sides of the controversy. There is dependence and there is interdependence.

Is the natural and logical order of the sciences also the order of their development, that is, the *developmental* and historical order? This question was discussed controversially by Spencer, Bain, Fiske, Lester Ward and others, with special reference to Comte's "hierarchy of the sciences". The term *hierarchy* is inapt. These are not priestly orders. Comte, philosopher that he was, tried to prove that the logical order is also the historical order or at least issues from it and is dependent on it. But his doctrine was effectively overthrown by Spencer and after him by Fiske. There was less truth indeed in the notion of historical succession than in that of *dependence,* by Comte termed *the filiation of the sciences.* This term Ward adopted and adapted the idea.[14] Spencer had rejected this too: "There is no true filiation of the sciences." [15] That Spencer was right in his first negation and wrong in his second was maintained by Robert Flint,

[14] Ward, *Op. cit.,* pp. 68–70.
[15] "The Genesis of Science," p. 27.

whose mind was not less competent than Fiske's and Ward's to judge of this matter.[16]

In attempting to resolve these confused or conflicting views we should first state certain distinctions between the different orders involved. *The order of nature* is partly real and partly conceptual; it is a plexus of relations, involving some that are developmental, progressive, and evolutional. The *developmental,* or *evolutionary, order* is part of, or an aspect of, the more complex order of nature, which comprises the *genetic* order of organic forms and the natural order of classes and genera, etc. These are the natural orders, linked together in the order of nature. Grounded on this is *the natural order of the sciences,* comprising only the *natural sciences,* and with some conceptual factors. Continuous and conformable with this is the *logical order,* comprehensive of all the sciences, natural, mental, and social, — of all scientific studies, including also the correlative historical, technological, æsthetic, and philosophical studies, that is, a complete survey of knowledge and thought. The logical order thus differs from the natural order in admitting more and broader conceptual relations and extensions. The human develops from the natural. As our problem is to produce a complete series of fundamental sciences and studies as a basis for systematic classification, it is the extended *natural and logical order* that concerns us in these chapters, and it is that which we intend to denote by the briefer term *logical order,* tho sometimes by the correlative term *natural order of the sciences.*

The *developmental,* or *historical,* order of the sciences is related to the logical order as the succession of prior developing stages, historically regarded or surveyed as a whole, is related to the present, developed stage of the series of sciences. The two orders, however, are not the same. Spencer was evidently justified in his contention. Ward and Flint

[16] Flint, Robert, *Philosophy . . . and a History of Classifications of the Sciences,* pp. 231–2.

were also right in their qualified defense of Comte. We shall consider their views again in Chapter XVIII.

Men first simplified the simple; they soonest attained to generalized knowledge of the simplest, most apparent, and most frequently recurrent facts or phenomena, especially those that were concrete and in relations that could readily and methodically be investigated — in brief those that were of human interest and accessible. The elementary facts and relations were studied first; the generalized and organized knowledge of these ensued; the principles and laws have been subsequently derived, and formulated. This is true of all the sciences; each has had its primitive stage, tho not all at the same time; each has its elements, or rudiments, and its generalizations, antecedent to its abstractions, principles, and laws; each has developed and progressed from the simpler and more accessible data and relations to those that are more complex, remote, and difficult of access.

The first generalizations were the simple facts of number and language, of measure and experience, of common knowledge of physical objects and actions, and of arithmetical, geometrical, and logical relations. Hence arose the elements of arithmetic, geometry, physics, mechanics, logic, and grammar. From these rudiments have grown up the respective branches of science, some general, some special, some formal, and some descriptive. These sciences of primitive origin and earlier growth have attained to high development and are now no longer elementary sciences. Sciences of more recent origin may be in their elementary stages. In this sense there is a *historical* succession. There are not only elementary stages and developed stages but there are old sciences and there are new sciences. There is a *developmental* series and an implicated *historical* series. They are closely related and may in fact be regarded as one.

But the several sciences are complex, and, while elementary in some branches, they may be highly developed in other branches. So the developmental and historical series can not be determined

simply, being related to and interwoven with the logical order but by no means identical with it. Moreover the sciences have developed not only by progressive analysis, differentiation, and specialization, and conversely by progressive generalization, abstraction, synthesis, and comprehension, but they have also in their development been affected by certain conditions that do not affect the logical order, and which therefore produce certain divergences between that order and the developmental order.[17]

Historically, mathematics was indeed one of the first sciences to attain any high degree of generalization, and therefore it merits the first place in both orders. On the other side of this argument Spencer urged that a rudimentary knowledge of physical facts must have preceded even the beginnings of arithmetic. Moreover the recent conceptual development of abstract mathematics both in generalized and in specialized methods is more extraordinary, if comparison be valid, than co-temporaneous progress in sciences of distinctly recent development, such as sociology and meteorolgy. Yet, notwithstanding the comparatively greater modern development of mathematics, the historical as well as the logical priority of this science is undeniable.

Indeed, in view of what has been said in the preceding paragraphs, if the logical order is regarded as a series of fundamental studies in the *present advanced stage* of development, the developmental order should be regarded as the *progressive series of stages* from the most primitive and elementary to the most organized and developed, regarded as having progressed crosswise to the logical series, presenting the analogue of a two-dimensional process (one dimension being temporal) culminative in the logical series.

Comte argued that the logical order is not only the same as the historical order but is *dependent* on it in the sense that each more special and more recent science is dependent for its results and development on those that precede it in the historical series, or conversely that those which developed earlier supply principles and methods to those that have developed since. Spencer, denying the historical "filiation", applied a similar principle of *dependence* to the gradation by speciality and complexity, arguing that each more special and complex science thus depends on those that are more general and abstract. There is something in both these interrelated principles, in both kinds of dependence, but, as we have observed before, there is *interdependence* rather than any complete serial dependence.

The progress of theoretical physics has especially depended on mathematical physics. Chemical theory has awaited the develop-

[17] See Spencer's essay on "Laws in General", reprinted with revisions from the first edition of his *First Principles;* also Fiske's *Cosmic Philosophy,* v. 1, Chapter VIII. Both writers show that the conditions considered have indeed been effectual in determining the course of scientific development.

ment of physics and of physical chemistry. Biology has lagged for lack of more positive knowledge in chemistry, while chemistry has gained little from biology, and physics less. Psychology has now joined hands with Biology, and there is give and take on both sides. The same may be said of Sociology and Psychology. From these relations and many more we may infer that there is a general but incomplete serial and correlative dependence of the logical order on the order of gradation by speciality and the developmental order. In short, the three orders are correlated and correspond more or less closely.

It thus appears that Ward and Flint were as near right in sustaining this correlation of dependence as Spencer was near wrong in denying it and all filiation of the sciences in the developmental order, whereas in other pages he eloquently maintained their interdependence.

As regards again the principle of gradation, the more general or abstract sciences are graded by their generality, comprehension, and scope; the more special or complex sciences are graded by speciality of scope and are moreover subordinated by their dependence; for specialization depends not only on division, definition, and analysis, but on the application of methods derived from the more general sciences and of principles adduced in them.

4. THE PEDAGOGIC ORDER.

Tho not altogether the same as the logical and developmental orders, the pedagogic order is largely correlative to those orders. Education, too, begins in natural learning of simple facts in many fields. Secondary and higher education more closely follow the logical order, and thus a comprehensive synthesis of the conceptual systems is attained.

There is a third order of major importance, the *pedagogic order*. To affirm that this is, or should be, the same as the logical and the developmental orders, would be to set up a false simplification. Yet there seems to be considerable truth in it. The individual mind acquires, as the racial mind has acquired, first the knowledge of commonplace physical objects, then of familiar kinds, then of numeric and geometric relations and measures, then of remoter objects, foreign countries and peoples, exotic plants, uncouth animals, and the distant stars. Later it attains to the generalizations, theories and truths of mathematics, physics, biology, psychology, sociology, economics, philology, ethics, and æsthetics, etc. The racial and social are *composite* of the individual in the ag-

gregate, and must therefore consist largely of similar experiences in similar sequences or orders. Of course the order in which knowledge and science are "naturally" acquired by the individual primitive mind or the mind of the modern child is not quite a pedagogic order in the sense of modern social pedagogics. Natural learning in that sense depends more on circumstances and interests. But a pedagogic order in keeping with a true social philosophy of education would have regard not only to the present, objective, natural, and environmental interests but also to the past acquisitions of the racial mind and its social and ethical purposes.[18] The pedagogic order accordingly would comprise the logical, the scientific, the historical, the social, the ethical, the religious, the political, the economic, the æsthetic, and the philological, and would therefore be closely correlated with the natural and logical order and with the developmental order.

"We cannot commence the study of science at any point nor prosecute it in any order we please. Nature has determined both where we ought to begin and what path we ought to follow. It is very far from a matter of indifference which of the mathematical sciences we commence with. If we plunge into natural philosophy without any mathematics to buoy us up we are likely soon to repent of our foolhardiness, and we are certain not to swim very far. We shall make a similar mistake if we enter on moral philosophy without having made ourselves acquainted with the leading truths of psychology. Now a philosophy of science worthy of what it should be would inform us at once what science was the natural antecedent of any other science, the condition of its intelligibility. It would, in fixing the order of the sciences, fix likewise the order of their rational study. It would thus lay what is the very corner-stone of the science of education — that without which no such thing as a science of education can exist." [19]

Education as a process of developing concepts and synthesizing these into more comprehensive complexes and systems, must begin, as does the process of natural learning, and the process of science development, with the rudiments of each science, the simpler, more concrete, more obvious facts; and

[18] As regards the status of the so-called "culture-epoch theory", as modified, see *supra*, pp. 87–8.

[19] Flint, *Op. cit.*, pp. 21–2.

later it should proceed to the complex and the recondite, and to generalizations, abstractions, theories, principles, and laws.[20] Accordingly primary instruction in the elements is necessarily grounded in the natural learning of simple facts in the child's early interests in whatever fields of common knowledge; and the secondary curriculum and the higher education closely follow the logical order of the sciences and the gradation by speciality, from mathematics to physics, to chemistry, to biology, to psychology, and to sociology; from history to civics, to ethics, to politics, and to economics; from languages to literatures, and from arts to technologies. But, because developmental, the curriculum progresses, like the developmental order, in a succession of grades crosswise to the logical order in which it should culminate. First there are elementary courses in arithmetic, nature-study, and geography, in languages, histories, and arts. On these elements are grounded the secondary courses in algebra, geometry, physics, chemistry, biology, botany, zoölogy, and anthropology, while the studies of languages, literatures, histories, and arts are course by course advanced. Subsequently on the logical, mathematical, physical, biological, and historical foundations are built up the higher studies, astronomy, geology, psychology, sociology, economics, ethics, philosophy, and æsthetics, while more advanced courses of history, philology, and literature are pursued, and more special courses are selected in physical or in social science, in education or in philosophy.

Thus, by education, with the development of the mind's capacities and abilities, should be attained a comprehensive synthesis of the order of nature and the conceptual systems of science and philosophy, together with understanding of history and human nature, community in the social and spiritual concerns of mankind, intellectual interest in the literatures, appreciative taste in the expressive arts, and the higher enjoyments of human life.

[20] *Cf.* Dewey, *How We Think*, pp. 140–2.

5. FIVE TABLES SYNOPTIC OF THE CORRELATIVE ORDERS.

The correlation of the three orders is reaffirmed, with special regard to the natural order of the sciences. The three orders are then shown in three tables, preceded by one representing the order of nature and followed by one tabulating the order of gradation by speciality; and these five tables are described. Their correspondence is shown. The validity of the natural order, and of the principle of *gradation by speciality*, is averred. The natural order may be regarded in the analogies of a tree and of a helix.

These three orders that we have distinguished in general are so correlated that they may to a large extent be combined. When they are considered more in detail and the sciences and studies in each order named, we shall find indeed that they are nearly the same. This amounts to saying that the natural order of the sciences may be approximated from the several points of view — with a few divergences; and that it may serve many purposes. "Sciences, in so far as they can be grouped at all, simply represent the natural groups of phenomena, and to determine the natural order in which phenomena are related to one another as indicated by their respective antecedence and sequence in the march of evolving forces, is to determine the natural order in which the sciences stand to one another, and that in which alone they can be successfully studied." [21]

To substantiate the foregoing statements let us now compare the three orders in tabular outline, preceded by a table representing the order of nature and followed by one showing, disengaged from details, the Order of Gradation by Speciality.

Table I arranges terms for generalized real entities, relations, classes, and mental products, the things of nature and human nature. It is both objective and conceptual. It does not name the branches of knowledge, or study, as such, nor unreal conceptual entities and relations. Of course it does not represent the whole order of nature, for that is complex beyond comprehension and cannot be reduced to any tabular, schematic synopsis, such as this is.

Table II is partly correlative to Table I and partly complementary to it. It is conceptual and may be regarded as subjective in view rather than objective. It regards knowledge, mental products; it names sciences and technologies, humanities and arts. It

[21] Ward, *Dynamic Sociology*, v. 1, p. 147.

is duplex, or two-dimensional, representing crosswise the progress from primitive common knowledge and elementary study (in individual minds and in racial) thru scientific analysis and conceptual synthesis to the generalizations and theories and more comprehensive systems of the sciences and technologies, arts and histories, and branches of philosophy. Notwithstanding essential differences, this table resembles Table I enough to show that the development of knowledge is correlative to the order of nature, somewhat as are subjective and objective correlates. What is complementary to that order is derived largely from conceptual synthesis and comprehension. Being subjective and conceptual, this table even more than the first is likely to be incomplete and subject to change and correction.

Table III is also two-dimensional, representing vertically the development of knowledge from primal perceptions and common knowledge of things in general, of objects, properties, relations, etc. (first column), thru language, arithmetic, nature-study, the elements of science, and the histories, to the studies of mankind and human mind, culture, society, arts, and literature; while horizontally it represents progress from all those elementary studies thru implied grades and courses to the generalized, theoretic, and comprehensive scientific and philosophic, historical and cultural studies. As representing the objects of education and realities to be revealed thru and attained by education, this order may be regarded as both objective and subjective. Table III therefore is as closely correlated with Tables I and IV as with Table II. It is, like Table II, of course largely conceptual, incomplete, and liable to change and correction.

Table IV represents the natural and logical order of the sciences and studies. It permits of some simplification. The sciences are named and classified. The fundamental sciences and studies are shown forth by the larger type; the derivative and subordinate are indented as is usual in synopses. This order is dependent on the order of nature as shown in Table I, but is dependent also in some respects on the developmental and the pedagogic orders, tho the last is determined more by this order as a consummation purposed by education.

Table V exhibits more simply still the series of fundamental sciences, with a few of their most important composites and derivatives, in *gradation by speciality*. In Chapters XIV and XV this serial order will be extended into a classification of the sciences and other studies in logical order.

Comparison of the order of nature, as represented in Table I, with the correlative synopsis of knowledge development in Table II will support the statement that the system of knowledge proceeds from the primitive concepts of things and their relations, of objects real and concrete, physical and natural, to the study of their actions

and mechanisms, to the analysis of these and their relations, to the discovery of the constitution and organization of bodies and the functions of their organs, to the revelation of constant relations determinative of these organizations, functions, and reactions, and to the extension of analytic and synthetic methods into the studies of mental and social processes and products, of ethical and æsthetic relations and ideals. This developing knowledge enlightens the human intellect with better understanding of the realities of existence and experience, the relations and conditions of nature and of life; and furthermore the knowledge of constant relations leads to the discovery and application of means to control in some measure natural actions and functions, as well as mental and social activities and tendencies.

These five tables all rationally coincide as regards the order of the sciences and studies. They show that the order by gradation in speciality is well based logically and conceptually on the order of nature and the natural order of the sciences, that it is well rooted in the order of the development of knowledge, and that it should largely determine the pedagogic order. There may indeed be disagreement with and criticism of some broad conceptions and some details, but the validity of these derivations from science and from logic is on the whole so patent that the importance of these conclusions must be evident and acknowledged. The truth of the principle of Gradation by Speciality as the proper basis for a scientific and pedagogic classification of the sciences must accordingly be conceded.

In view of the principle of the relativity of subordination and coördination,[22] the serially coördinated main classes may be regarded as successively subordinated in gradation by speciality. But, instead of representing this order as scalar, it would be truer — tho somewhat fanciful — to regard this order of knowledge in the analogy of a helix, grounded on the broadest experience of particular diverse facts and the analytical, descriptive data of common knowledge and natural science, rising thru a concentric spiral of gradation in speciality and culminating in synthetic comprehensive truths. When viewed from above, this helical order could be decentralized and thus could be compared with an encyclopedia of knowledge; when approached on the levels of life, it would appear as a growth — as the tree of knowledge.

[22] *Cf. supra,* pp. 152–5.

I. THE ORDER OF NATURE.

Substance, Matter, Reality.

Atoms, Electrons, Molecules.
Properties, Qualities.
Objects, real and concrete.

Media, ætherial, electronic, and other.
Energy. Purpose.
Relations.

Space (location), Time (sequence), and Relativity.
Measure, Units, Standards.
Classes, Kinds, Groups; Likeness, Equality, Analogy.
Recurrence, Cycles, Constants, Norms, Laws.
Correlation, Functional relations.
Determinations, Causes.

Physical Actions and States.

Forces, Attractions, Repulsions; Potential, Gravitation.
Pressures, Reactions, Resistance, Elasticity.
Equilibria, Rest.
Motions, Vectors, Resultants.
Oscillations, Vibrations: Orbital, Periodic, Harmonic.
Radiations.
Physical states, Phases.
  Gases, Liquids, Colloids, Crystals, Solids.
  Electric and Magnetic states.

Chemical Elements and Actions.

Chemical combinations, Compounds, Solutions, Mixtures.
Minerals.

Bodies, Structures (Inorganic).

Physical systems, Mechanisms, Machines, Instruments.
Astronomic bodies.
The Earth: Geologic, Physiographic, Meteorologic structures and states.

Organisms.

Genetics, Cells, Organization, Development, Evolution.
Organic forms and functions.
Natural kinds, Classes, etc.
  Plants.
  Animals.
    Mankind.

Mind.

Mentality, Memory, Intellect.
Concepts, Ideas, Beliefs, Complexes.
Behavior, Instincts, Volitions, Habits.
Subjects,

Societies, Communities, Ethnic groups, Social groups.

II. THE DEVELOPMENTAL ORDER OF KNOWLEDGE.

EMPIRICAL AND DESCRIPTIVE. CONCEPTUAL AND INTELLECTUAL.

Perceptions, Cognitions of:

Objects, Events, Meanings;
Sequence, Location,
  Likeness, Equality, Recurrence;
Measures, Units;
Forms, Symmetries;
Changes;
Motions.

Concepts and Syntheses of:

Entities, Properties;
Conceptual Space and Time;
Classes, Words, Symbols, Language;
Number, Equation, Standards;
Formulæ, Limits, Projections;
Graphs, Functions, Correlations;
Components, Vectors, Coördinates.

Empirical knowledge of:

Physical bodies, structures;
Elements, Components;
Actions;
  Pressures;
  Waves, Vibrations;
Sounds;
Heat phenomena;
Light, Colors, Qualities;
States of Matter, Properties;
  Gases, Liquids, Crystals;
  Changes of state;
Electric, Magnetic phenomena;
Mechanisms, Instruments;
Chemical substances, actions;
Minerals;
Mixtures.

Rational knowledge of:

Matter, Atoms, Systems;
Molecules, Organization;
Forces, Causes, Energy;
  Kinetics, Statics, Equilibria;
  Radiations, "Quanta," Media;
Acoustics;
Thermodynamics, Heat;
Optics, Physics of Light;
Theoretical Physics;
Phases, Crystallography;
Colloids, etc.;
Electrodynamics;
Mechanical Engineering;
Chemical Elements;
  Compounds, Analyses;
  Solutions, etc.

Descriptive knowledge of:

Astronomical bodies:
  Stars, Comets, Nebulae, etc.;
  Planets;
    Earth,
      Surface,
      Atmosphere, Seasons, Weather.

Organic bodies:
  Plants and Animals;
    Forms, Organs, Kinds;
    Cells, Tissues, Functions;
    Embryos;
    Development, Variations;
    Fossils;
    Adaptations, Homologies, Species.

Theoretical and conceptual:

Cosmology, Cosmophysics;
Astrophysics;
Orbits, etc.;
Geological science;
  Geographical science;
  Meteorological science.

Biological science:
  Biology, Botany, and Zoölogy;
    Morphology, Anatomy;
    Cytology, Histology, Physiology;
    Embryology;
    Genetics, Ontogeny;
    Paleontology;
    Phylogeny, Organic Evolution.

Knowledge of Human Nature:

Human body, organs, states,
    Activities, functions;
    Diseases, Deformities;
    Differences, Races, Fossils;
Mind, Behavior, Memory,
    Feelings, Emotions, Instincts;
Learning, Correlations, Abilities;
Societies, Social products, ideas;
  Families, Communities, Morals;
  Ethnic groups, Customs,
  Traditions, Rites, Beliefs;
  Religions, Churches, Doctrines;
  Laws, Governments, Courts;
Goods, Values, Exchanges, Money;
Arts, Skills, Industries, Games.

Anthropological sciences:

Anatomy, Histology;
Physiology, Hygiene;
Pathology, Teratology;
Anthropology, Physical, Racial;
Psychology;
Pedagogics;
Sociology, Social Psychology;
Ethics;
Ethnology;
Folklore; Mythology;
Theology, Ecclesiology;
Political Science,
    Jurisprudence;
Economics;
Æsthetics, Technology.

Languages and Literatures:

Speaking, Reading, Writing, Forms;
Acting, Theatricals, etc.

Philology:

Linguistics,
Rhetoric, Criticism;
Dramatics, Oratory, etc.

III. THE PEDAGOGIC ORDER.

ELEMENTARY LEARNING.	ADVANCED STUDY.
Common knowledge of things: Meanings, Words, Names; Kinds, Classes, Definitions; Properties, Qualities; Relations, Spatial, Temporal; Numbers; Mother Language; Spelling, Reading, Writing; Measures, Units, Standards; Projections, Coördinates; Simple correlations, judgments; Generalizations.	**Science and philosophy:** Terminology, Nomenclature; Classification, Taxonomy; Analysis, Testing; Mathematics, Geometry; Arithmetic and Algebra; Linguistics and Languages; Etymology, Grammar; Metrology, Trigonometry; Descriptive geometry; Logic and Methodology; Scientific principles, laws.
Nature study: Natural objects and kinds; Properties, Relations; Structures, Actions, Motions; Sounds; States of matter; Gases, Liquids, Crystals, Solids. Heat, Light, Electricity.	**Natural science:** Descriptive natural science; Physics, Mechanics, Kinematics; Acoustics; Hydrodynamics, Aerodynamics; Crystallography; Thermodynamics, Optics, Electrodynamics.
Manual training, Mechanism.	**Applied Mechanics, Engineering.**
Chemical substances, actions: Minerals.	**Chemical science:** Mineralogy.
Astronomical bodies, motions.	**Astronomy:**
Geography, Physiography: Surface, Human Geography; Weather, Winds, Clouds.	**Geology;** Petrography; Geography, Physiography; Meteorology, Climatology.
Plants and Animals: Forms, Organs, Kinds, Tissues; Functions, Habits, Habitats; Fossils; Generation, Inheritance; Variations, Homologies, Adaptations.	**Biology, Botany and Zoology:** Morphology, Histology, Taxonomy; Physiology, Ecology; Paleontology; Genetics, Ontogeny; Phylogeny, Eugenics.
Mankind, Human Nature: Human body: Anatomy, Functions, Health; Physical abilities, Plays; Diseases; Differences, Races, Fossils.	**Anthropology:** Physical Anthropology; Anatomy, Physiology, Hygiene; Athletics, Physical culture; Pathology, Medical science; Racial Anthrop., Anthropogeny.
Mind: Mental States, Behavior; Mental differences, Diseases; Learning, Abilities, Methods.	**Psychology:** Descriptive, Physiological; Differential, Racial, Psychiatry; Education, Pedagogics.
Society, Economies: Communities, Institutions: History, Customs, Peoples; Morals, Religion, Mythology; Civics; Laws; Social economies, family and private.	**Social sciences, Sociology:** Sociological Psychology; Ethnology, History, Folklore; Ethics, Science of Religion; Political science; Jurisprudence; Economics.
Arts and Industries.	**Æsthetics, Technologies.**
Languages and Literatures. Reading, Writing, Speaking; Forms and traits; Acting, Theatricals.	**Philology.** Linguistics; Rhetoric, Oratory; Literature, History, Criticism; Dramatics.

IV. LOGICAL ORDER.

Science and Philosophy.
- Ontology, Cosmology, Theology.
- Epistemology.
- Logic and Methodology.
- Mathematics.
- Metrology and Statistics.

Natural (Physical) Sciences.

Physics.
- Mechanics, Applied Mechanics.
- Special Physics.
- Special Mechanics, Sound, etc.

Chemistry.
- Physical Chemistry.
- Mineralogy, Crystallography.
- Analytical Chemistry.
- Special Chemistry.
- Chemical technology.

Special Natural Sciences.
- Natural History.

Astronomy.

Geology.
- Physical Geology.
- Historical Geology.
- Geography, Physiography.
- Meteorology and Climatology.

Biology.
- Morphology, Histology.
- Physiology, Ecology.
- Genetics, Ontogeny.
- Paleontology
- Phylogeny.
- Botany.
- Zoölogy.

Anthropology.
- Physical Anthropology.
- Medical Sciences.

Psychology.

Education.

Sociology.
- Ethnology.
  - Folklore.
- Human geography, Ethnography.
- History, Social, Political.
- Religion, Ethics, and Theology.
- Ethical, Applied Social Science.
- Political Science.
- Jurisprudence and Law.
- Economics.

Arts, Fine, Useful, Recreative.
- Æsthetics.

Philology.
- Linguistics, Languages.
- Literature and Literatures.
- Rhetoric, Oratory, Dramatics.

V. BY SPECIALITY.

Science and Philosophy.
- Ontology, Cosmology, Theology.
- Epistemology.
- Logic and Methodology.
- Mathematics.
- Metrology and Statistics.

Natural (Physical) Sciences.

Physics.
- Mechanics,
- Special Physics.
- Special Mechanics.

Chemistry.
- Physical Chemistry.
- Mineralogy, Crystallography.
- Special Chemistry.
- Chemical technology.

Special Natural Sciences.

Astronomy.

Geology.

Geography.
- Physiography.
- Meteorology.

Biology.
- Morphology.
- Physiology and Ecology.
- Genetics.
- Paleontology.
- Phylogeny.
- Botany.
- Zoölogy.

Anthropology.
- Physical Anthropology.
- Medical Sciences.

Psychology.

Education.

Sociology.
- Ethnology.
- Folklore.
- Ethnography, Human geography.
- History, Social, Political.

Religion, Ethics, Theology.

Applied Social Science.

Political Science.

Jurisprudence and Law.

Economics.

Arts, Fine, Useful, Recreative.
- Æsthetics.

Philology.
- Linguistics, Languages.
- Literature,
  - Literatures.
- Rhetoric and Criticism.
- Oratory.
- Dramatics.

CHAPTER XIII

PRELIMINARY TO THE CLASSIFICATION OF THE SCIENCES.

1. THE PURPOSE AND THE PROBLEM.

With classifying the sciences and studies we are less concerned than with bringing them into an order and system. Classification *of* the sciences is distinguished from classification *in* the sciences. The problem of constructing a classification that is both scientific and practical involves the principles of consistency with the order of nature, of subordination, of gradation by speciality, of the relativity of classifications, and of collocation for a maximal efficiency. The resulting system, however serviceable, will of course be imperfect and only relatively permanent.

That classification is an essential method of science was affirmed in the second section of Chapter VIII. That science is the conceptual, synthetic, and systematic correlate of the order of nature, that its concepts and conceptual relations are super-personal and relatively permanent, that the several sciences, centered about special concepts, interests, and problems, are distinct and definite with regard to these, tho interwoven and interdependent, and that they are graded in speciality, each more special science being in some measure derived from and dependent on those that are more general — these were conclusions of the eleventh and twelfth chapters, in which it was also shown that the principles of Subordination of Special to General Classes and of Gradation by Speciality are the true bases for a scientific order of the sciences.

In the terminology the classification *of* the sciences is to be distinguished from classification *in* the sciences (special classifications of scientific data). The system of the sciences comprises not only a classification of the sciences but many classifications within the several sciences. With these latter

we are less concerned in this book. The definition of the former term in Baldwin's *Dictionary of Philosophy* is as follows:

"The systematic arrangement of the various branches of knowledge or of positive science in order to fix their definitions, determine their boundaries, bring to light their interrelations, and ascertain how much of the task of science has been accomplished and what remains to be done. The value of such a classification depends not merely on the encyclopædic or didactic uses to which a survey of the sciences may be put, but also on its utility as an instrument of intellectual progress."

Order and system is the general purpose in view, for clearer connection of the broader studies and more consistent arrangement of the special studies. It is our project first to grade by speciality the fundamental sciences, the major studies, and their chief composites, then to systematize their sub-sciences and more important branches, then thirdly, to arrange and to collocate their minor branches and subdivisions as consistently as is feasible with regard to their natural relations, subordinations, and coördinations, and with regard to practical convenience. This is for system and order in our knowledge, in our studies, and in our use of books in libraries. Strictly we are concerned less with *classifying* sciences (arranging them in classes) than in finding their natural or logical *order* and *systemizing* them consistently and conveniently. This indeed involves certain classifying, or rather grouping of sciences, and of their derivative and subordinate subjects.[1]

Putting our knowledge in order should indeed make for mental clarity and efficient control. Scientific research having been organized and rational philosophy clarified, knowledge should become more adequate and intelligent and pur-

[1] *The System of the Sciences* is the title of Wilhelm Ostwald's important essay (cited on p. 416). Edmond Goblot preferred the same title, *Le Systeme des sciences,* for his second book (published in 1922) in this field. This is a much better book than his first, *Essai sur la Classification des sciences* (1898), from which we have quoted several times, and it should be read by all who are interested in the subject. Regarding the major sciences, he emphasized that they are not classified but as individuals are grouped and systemized.

pose should become more coherent. Education should organize in the social mind what in this knowledge and purpose is intellectually, socially, and economically valuable. Social organizations should arise out of all vivid interests, should adapt their purposes to relevant organizations of thought and should avail themselves of the organized knowledge that would aid their purposes. All this organization should be not merely structural but indeed functional, not static but progressive, not oppressive but liberal, cherishing freedom, individuality, and originality.

Having distinguished and graded the fundamental sciences and major studies, the *problem* of systemizing the branches and sub-sciences and their subdivisions in consistency with the most important natural and real relations so as to achieve *the maximum of convenience attainable under the conditions for the manifold purposes to be served* — this proves to be a problem of extraordinary difficulty. The feasibility of solution is often denied in respect of all three specifications. First it is argued that the sciences can not be delimited or separated. The reply to this is given in Chapter XI, § 2, and seems conclusive. The sciences are sufficiently distinct and individual. Secondly, it is denied that there is any "natural order" or permanent real basis for the classification of the sciences. The second section of this chapter and the last section of the preceding chapter, also the last paragraphs of Chapter XI, § 5, refute that denial effectively. Thirdly, it is illogically asserted that there is *no* classification that will most conveniently serve all the manifold purposes. But, as the terms involved are relative, there must be *some* maximum of relative convenience attainable from *some relatively best* system.

We should not expect to find real or natural relations by which to classify every study or branch of science, nor that all related classes may be collocated for convenience, nor that all concepts may be consistently synthesized. Our classifications must, it is true, be partly conceptual and relative to

the purposes entertained. They would rest on real relations where these are existent and definite, and on conceptions where these are relevant to the purposes. This is the principle of the *Relativity of Classification,* as distinguished from that of *Relativity of Classes.*[2] If a classification serves many purposes, then so much the more serviceable will it prove to be. Sometimes, however, the classification in a science or study serves only one dominant purpose, to which convenience is most important. Our problem of systemizing these classifications permits, we re-affirm, of feasible solution.

Those who deal in negatives will have their say and their day. But life and mind, science and art, are affirmative and positive. So long as our affirmations and our positions are relative to the facts of life, to the data of reality, and to the verities of science, we are on solid ground, and we may build structures that should prove serviceable and relatively durable. We shall remember that they are relative, imperfect, and not immutable.

2. THE POINT OF VIEW.

Philosophic views may lead to classifications differing from the naturalistic, but they are little better than arbitrary systems. The scientific, philosophic, and humanistic views tend to converge. The psychologic, the pedagogic, the historical, and the ethical views are severally considered; they may differ from, but they are not very inconsistent with the system of natural science. What we are intent upon here is neither merely arbitrary nor practical classification, but a consistent basis for scientific classification adaptable to most other logical or rational views and maximally efficient in practical application. This we find in the naturalistic view.

Even a scientific classification embodying natural and real classes and relations is more or less conceptual in its synthesis. It will therefore depend in some respects on the selective interest and the principles of the underlying philosophy and purpose. The philosophy of naturalistic realism and the purpose of applicable organization of knowledge have been affirmed in preceding chapters. Other important interests and viewpoints should now be considered, and whether these are consistent with the scientific.

[2] The principle was stated more generally on pp. 123 and 156.

Philosophic views at variance with naturalistic realism may lead to very different rational systems of classification. Most of these are little better than *arbitrary* or irrational systems and are less justifiable than merely *practical* classifications. The highways and byways of the history of thought are strewn with wrecks of such unsubstantial structures. We shall have a look at some of these in Chapters XVII and XVIII. Until then we will refrain from certain generalizations. But in so far as philosophy rests on knowledge, it tends to become scientific as knowledge becomes organized and verified; and in so far as philosophy is the product of *human thought ranging beyond verities,* it is affected by human *interest* and *purposes.* The scientific, the philosophic, and the humanistic viewpoints tend to coalesce, and they are ultimately, we believe, *the same from three converging aspects.*

The faults of philosophic classifications are mainly the faults of the philosophic views they embody. Idealism in its modern forms surveys the same reality that science has revealed, but from the opposite pole of the subject-object relation, and that is likewise antithetic to the human view of realities. Since, however, the same order of nature is scanned by all three views, the same classification should in the main serve them all, tho of course with some adaptations. The older solipsistic and the transcendental forms of idealism lead to mazes of conceptual relations so remote from human experience and from natural science that they may require conceptual structures as incompatible with scientific relations as they are with the realities of human life. Generally speaking, religious, metaphysical, and imaginative systems are doctrinal and partial in their views of the order of nature and may lead to systems of theology and cosmogony as incongruous with science and as grotesque in their supernaturalism as those that might proceed from the doctrines, for instance, of Brahminism, Theosophy, and Nietzscheism.

An *ethical* system should conform to a humanistic and truly philosophic system. An ethically purposed classification might differ somewhat from one that is scientific thruout, especially in the relation of ethics to sociology and to biology; but, if the ethics is properly social and the sociology is based on the science of human nature, it should not differ radically from the classification established in the natural sciences.

Of any *humanistic* or sociological system that purports to be scientific or truly philosophic the same ground is by implication all the more positively affirmed.

The *psychologic* point of view, while scientific — for psychology is a science — may be antithetic to the naturalistic view, as the mental is opposite to the physical in the subject-object relation. It is knowledge that we propose to classify. First should come, according to that view, the science that investigates the mental basis of knowledge, and the branch of philosophy that discusses the nature and the scope of knowledge. Psychology, the science of mind, would accordingly be the basic science and the most comprehensive, including Epistemology, the philosophy of knowledge, Logic, the normative science of thinking, Ideology, the doctrine of ideas, and Sophiology, the study of beliefs, which might extend to folklore. Natural science would thus be regarded as the development of a system of concepts and would be subordinate to Psychology, whereas the reverse is true of the naturalistic view, in which Psychology is subordinate to the science of human nature, Anthropology. All the studies of man's culture and history, ethnology, sociology, and economics, the arts, languages, and literatures, should, however, be regarded as dealing with anthropologic and mental products. The radical difference between the two views is that in the psychologic system Psychology would stand either at the head of the series of fundamental sciences, or just after Philosophy and Epistemology, of which it would then be a branch. This latter alternative might, however, more properly be termed the *epistemological view*. In either case there is a distinctly different series or order. In the adaptable practical system proposed by the writer certain provision has been made for this alternative, in accommodation to this point of view.

Education is mostly mental, and the study of the process is largely psychological. In a psychologic system the subject Education would therefore be subordinated under Psychology, as the most important of the applications of that science. Under the naturalistic view it would be similarly related to psychology as a science of human nature. This corresponds also with the order termed *pedagogic* in the preceding chapter, in comparison with the natural order of the sciences, to which it closely approximates. It may seem inconsistent that this pedagogic order does not conform thruout with the psychologic order, but the former stands for the object of education, that which is to be revealed thru education — nature and human nature — and is therefore objective and naturalistic; whereas the latter corresponds to the psychologic view of life and the world, and the intellectual inquiry into reality and nature; moreover the pedagogic should be the order in which the facts of nature and life are presented to the developing mind, whereas the psychologic is the order in which the developing mind

subsequently rearranges, scientifically or philosophically, the subjects of its interest or study.

The *historic* is not only a basic viewpoint but a fundamental way of regarding facts; it is not only an aspect but a mode. The phenomena of nature, the data of science, and the events of human life may be regarded as *sequential,* or on the other hand they may be *classified* according to like characters. From the former proceeds the *historic order,* from the latter the descriptive, or *classificatory order.* The latter, however, may partly comprise the former, for things, whether like or unlike in other respects, may be like in some historical parallel or connection. We should bear in mind that the course of history, or the historic order of things and events in their actuality as objectively studied, is, tho correlative, not the same thing as the historical view or study or narrative of that objective order or course. Nor is that historical aspect the same as a classification relative to that aspect.

In science descriptive and classificatory data are woven across the sequential warp of history. Indeed even scientific explication by *causation* is pervaded by the sequential aspect. Not only events but physical phenomena and even mental changes are "explained" as consequences dependent on antecedent actions. This causative explication is sometimes considered more satisfactory and definite than explication by virtue of analysis, classing, relation, and analogy. All this is true of the successive stages of development, whether of an organism, a mind, a society, or an art. Every study therefore has its historical aspect, its historical data, its historical treatment, even as most studies have their theoretical or philosophical summits. History in this broad sense is no special science but a very general study, or general mode of regarding or treating all data and all studies. On this basis a classification of knowledge might proceed from History in general to the history of special sciences, humanities, arts, etc., whether in the natural or the psychological order, and thence to the respective scientific and theoretic studies. But then, what is usually termed *History* would have to be subordinated to descriptive social science as the history of social development and of political movements, etc. Such a *historical* classification would thus differ from the natural order mainly in placing General History first instead of General Philosophy and General Science; and also in being less inclusive of certain conceptual and metaphysical studies that do not fall in with the historical view, for instance, Epistemology and Logic, which would have to be subordinated to the history of philosophy, of ideas, and of thought.

These several views in which knowledge may be classified tend to coalesce with that of science based upon the order of

nature. Any classification of knowledge is of course dealing with knowledge rather than thought or imagination or feeling. Science as verified experiential knowledge is the soundest, most permanent material for such a classification, and it is but proper that the scientific view should thus predominate. The philosophical and the ethical, the humanistic and the sociologic, the psychologic and the pedagogic, the historical and the evolutional — all these conform more or less closely with the scientific and naturalistic.[3]

The psychological and the historical are the two views that differ most significantly from the naturalistic. In the first the difference arises from the opposition between subject and object, between the knower and the object of knowledge; in the second the difference rests upon the antithesis between the sequential and the classificatory. We have adopted the classificatory and the objective realistic views. It is customary to treat the fields of knowledge and of study objectively, not as empirical projections of subjective interests or activities. Thus the mind itself is classed as an object of study, and its products are related fields of study. Psychology is thus one of the special sciences, and is subordinate to the natural science of human nature. This does not disregard the older introspective psychology as a field, or as a method, but rather would objectify it and combine it with the experimental and descriptive studies.[4]

One of the commonest strictures regarding systematic classification is that it is relative and impermanent; that there may be as many classifications as there are classifiers, interests, and purposes; that each of these has only relative validity. The relativity and impermanence in general have been admitted, but, as regards scientific, philosophic, psychologic, pedagogic, and historical systems, this (as was stated in

[3] This statement is well supported by the careful study of the question in Erich Becher's *Geisteswissenschaften und Naturwissenschaften,* pp. 46–7, 54, and 75–6.

[4] Prof. G. T. Ladd contributed an excellent article bearing on this question to *Mind,* Oct. 1914. See especially p. 487.

Chapter XII, § 2) would affect the main structure less than the minor details. It is the metaphysical and imaginative systems, the religious, the æsthetic, and the poetic fabrics that conflict with the scientific and philosophic. These are fields not of scientific knowledge indeed, but of thought, feeling, and purpose, where each thinker may have his own peculiar system.

In Chapters XVII, § 1, and XVIII, § 4, some examples of such will be outlined and criticised. Here but one little fragment will be shown, a gem in its way, which is that of philosophical æsthetics, in this case contributed by one of the most respectable of psychological critics, Henry Rutgers Marshall. It is simply this:

The Real or True (in the broad sense)	a.	The Real of Impression—The Beautiful.
	b.	" " " Expression—The Good.
	c.	" " " Realms exclusive of a and b—The True (in the narrower sense of the term).

This is quoted by J. A. Thomson in his *Introduction to Science*, p. 171. If it were true, there would be no good impression, no beautiful expression, and the true would be neither beautiful nor good — which is quite contrary to æsthetic tradition; and Dr. Marshall could hardly have meant what this says.

Purposive practical classifications are and should be no less free and adaptable than the purposive metaphysical systems, but they are more to be respected, especially if formed from the scientific point of view. To some extent such would be embodied in a system that combines scientific and practical interests. In the main, however, it is neither particular practical situations that we are proposing to deal with, nor the ever-plastic products of the human imagination and volition; but we are attempting to establish a true basis for the order of the sciences and on this to erect a scientific system of all knowledge that would serve, not all the various interests indeed, but a maximum of the practical interests, economies, and technologies of human life, besides its institutions, morals, religions, and arts.

3. THE TREE AND ITS BRANCHES.

The tree of knowledge and the two-dimensional trellis of classification. Biology exemplifies three-dimensional complexity. A series (one-dimensional) of classes may be relatively and successively subordinate, tho regarded as coördinate in the schedules of practical classification.

The tree of knowledge, to return to this analogy, can only with difficulty be trained on the trellis of classification, for it resists reduction to a two-dimensional form. Yet there is something in the analogy. As Spencer remarked, with reference to Comte's use of the simile of the tree, it suggests that the branches of science have had a common origin, have been developing together, and continue to receive materials thus thru the unitary trunk from the common ground. The analogy is true to the unity and diversity of knowledge regarded as analytical and developmental. The tree ramifies. A tree in its natural freedom is flexible to the various winds, and neighbor branches, swaying together, may bring their branchlets into many different contacts. Or a vine may grow upon the branching structure of the tree and may intertwine its own tendrils in any degree of freedom. But if the tree be trained to a trellis, its branches cross in rigid contacts, and there will be less freedom for branchlets and twigs. The interrelations will thus be structural. On this structure, however, the freely growing vine may climb, and various free forms of life may live and function. In this extended analogy there is a suggestion of the relation of a structural classification of knowledge to the various functional uses of this classified knowledge in the freedom of thought and study.

But how is a branching classification to be conjoined with a scalar classification such as that which results from the principle of gradation by speciality? By making the trellis somewhat like a scaling ladder. Rambler rose-vines are often trained to a single post with slats nailed across it in an ascending series to bear the pink loveliness of June. So a ramifying classification may be reduced to a scalar series of fundamental sciences for a functional system of studies, tho it may not be so perfect nor look so lovely as a rose-vine.

Three-dimensional branching is especially manifest in certain sciences, where different divisions arise at nearly the same part of the branch. For instance, Biology forks one way into Physiology and Morphology and the other way into Botany and Zoölogy. This reduces to a cross-classification of Morphology and Physiology of Plants and of Animals. From Morphology there are minor branches for Anatomy, Histology, Embryology, Paleontology, and Genetics; from Physiology there are minor branches for Biochemistry and Ecology, etc. But under Botany and again under Zoölogy all these captions recur as it were crosswise. That is not all; there are complex relations. Cytology, the study of cells, leads into Histology, the study of tissues, and these studies merge into the study of Development, linking with Embryology and Embryogeny; and all of these studies, tho mostly morphological, cross over to Physiology in important relations. Plainly the science of Biology branches three-dimensionally, and it is too complex for mere cross-classification. It can hardly be reduced to a two-dimensional trellis, or schedule; yet this may be done, tho imperfectly, by first setting down the main branches (two-dimensional) indicated above, and then by bringing under them the minor branches (three-dimensional), as is shown by indention in a tabular synopsis and as is usual in subordination.

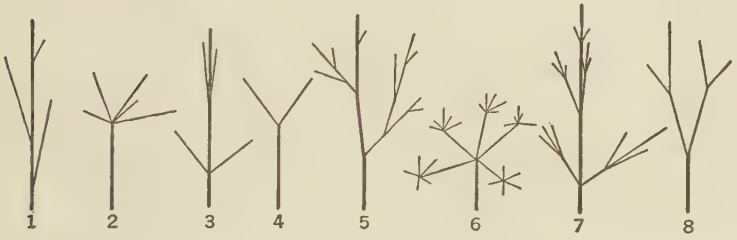
The divisions and subdivisions of the sciences and the studies derivative from them may in further analogy to the tree of knowledge be compared with the ramifications of arboreal branching. These analogies, while not close in their nature and not very important, may be of interest and in some respects may have pedagogic value.

Arboreal branching, or, more correctly, *phyllotaxis,* the branching of plant-stems, may be generalized under four types: (1) alternate, or spiral; (2) verticillate, cyclic, or whorled; (3) opposite; and (4) dichotomous, or forked.

Whorled, or cyclic, branching results from minimal or terminated development of the stem, whether of the type of spiral or of opposite pairs of shoots. In opposite phyllotaxis the stem is produced, and the pairs of shoots arise either in one plane (distichous)

or in two planes at right angles to each other. Dichotomous branching may be regarded as resulting from opposite branching with the terminal shoot undeveloped. Alternate branching may be regarded as equivalent to opposite or to dichotomous branching with one of each pair of opposite buds arrested in development. The growing shoots usually diverge more or less, producing a zigzag tendency, whether of alternate or of spiral mode. These four types are represented diagrammatically below (figs. 1 to 4).

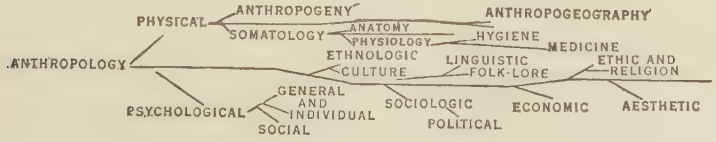
Any of these four modes may be successive or compound. Cyclic or opposite branches may produce whorled or opposite branchlets and twigs (figs. 6 and 7). Dichotomous forks may fork again and again (fig. 8). Alternate branching gives rise to alternate secondary branches and these successively to alternate or spiral branchlets and twigs (fig. 5).



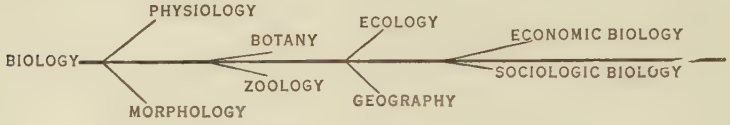
While these forms are typical of the young twigs and branchlets, they appear much less regularly in the larger branches, because so many of the shoots fail or the branchlets later fall.

In classification there may be forms analogous to all of these types; indeed there may be various combinations of two or more types, simple or compound. It would be needless to describe all such forms of classification. It will suffice to indicate and exemplify a few of them.

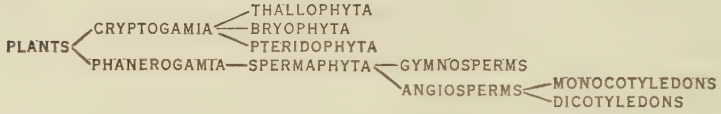
Subjects that are successively subordinate to a fundamental science or main subject, in gradation by speciality or with respect to some other general principle, may be compared with the alternate or spiral form of branching. For instance:



Coördinate branches of a main subject that continues to develop may be compared with the type of opposite, or cyclic, branching, as is exemplified by:

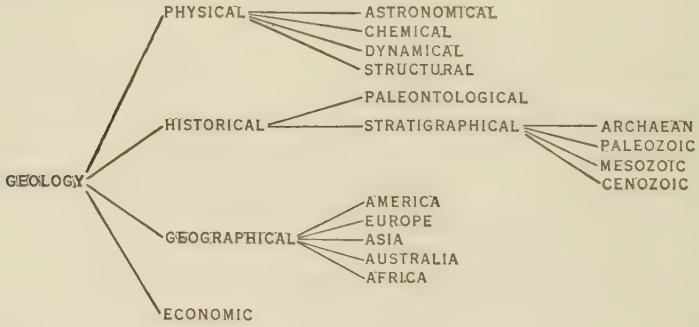


If the entire subject divides into two subjects, it is dichotomous, thus:



It will be noticed here that the branch Cryptogamia divides into three branchlets instead of following the principle of dichotomy. One may further remark that this trifid division has been modified in subsequent taxonomy.

If three or more subjects arise from the same central interest coordinately, there obtains the analogy of the whorled type of branching, for example:



The imperfection and difficulty of schedulizing elaborate classifications are increased by the usual mode of arranging the three-dimensional ramifications not by two-dimensional but by what are virtually consecutive one-dimensional schedules of captions and correlative notations. These difficulties, as complicating practical classification for libraries, will be dealt with subsequently.

In schedules of practical classification two or more branches from the same node of the stem, so to speak, or of a side branch, are usually treated as coördinate, even tho some be inherently subordinate. For instance, Botany and Zoölogy may be schedulized as coördinate branches, or sub-sciences, of Biology, or of the branch Morphology, tho in the genetic order and in the order of speciality Zoölogy is to be regarded as subsequent to and in this sense as subordinate to Botany. A scalar series, a gradation by speciality, is logically a series of successive subordinations. It is only for practical convenience that we schedulize them as coördinate. As these terms are used with especial significance in treating of practical classification, occasion is taken here to distinguish them in this aspect. The relativity of Subordination and Coördination is the eighth principle of classification in our list.

4. SOME TERMINOLOGICAL PRELIMINARIES.

Names of sciences and studies differ in different languages. Historically names may have changed in comprehesion. Sometimes there are two nearly equivalent names for the same study. The endings in many names indicate whether the studies are theoretical or descriptive. Ambiguity often inheres in the general use of the name both for the study and for its subject-matter. Examples of several kinds of usage are given.

The names of sciences may be transitory, and not all of them are international. They may be very different in languages other than the Indo-European. The slight divergences in spelling and in ending in the names derivative from the Latin and the Greek need not concern us, but the radical differences in the Teutonic and Slavonic languages are matters for consideration to those who classify and those who make classifications.

The French *calcul* is close enough to the English *calculus,* and to Latin derivatives in other languages; but the Germans have preferred the term *Analyse;* and in the French *analyse* and also in the English *Analysis* this term has superseded the older term, which itself had superseded Newton's term *fluxions.* Now the three terms, fluxions, calculus, and Analysis, stand for three different studies of increasing comprehension in the development of mathematics. In classification we must take care of such differences.

Economics has supplanted *Political Economy,* for the subject is broader than its political aspects. *Physics* in English has long outgrown its big-wigged ancestor, *Natural Philosophy,* for it is no longer a mere branch of philosophy. *Biology* has likewise succeeded to its precursor, *Physiology,* which in its medical aspects was in olden times called Physic.

In a few cases two names persist for the same science or for closely related aspects of the same field, or for different treatments of the same material. *Education* has come to mean more than *Pedagogy,* which connotes more specially the normative and practical study, while *Pedagogics* is used distinctively for the more theoretical study of educational processes and methods. *Linguistics* is the scientific study of language; *Philology* more broadly includes the study of the literatures. *Ethics* and *Æsthetics* are more scientific and philosophic than the historical and descriptive studies of morals and arts. Ethnology and Ethnography are closely related studies that will be distinguished in the next chapter.

Generally the ending *ic,* or *ics,* signifies a theoretical, scientific, analytical, or philosophical study, as does also usually the ending *logy,* whereas the ending *graphy* implies rather a descriptive study, such as Ethnography, Geography, Biography, Metallography, Oceanography, Cosmography, etc. Ethnology is comparative, Geology is synthetic, Biology is comprehensive, Cosmology is theoretic. Economics is theoretic and analytic rather than descriptive science of relations; economy is practical and generalizes economies.[5]

Sometimes, however, one term serves for two meanings, or more. *Metaphysics* in the narrower sense is the philosophy of being, of reality; in the broader sense it comprises also the philosophy of knowledge. *Ethology* has been used for Ecology, for Bionomics, for Ethics, and for the science of Character (Mill). *Politics* is a plexus of relations perplexing to citizens and even to politicians; but it is also an olden alternative name for *political science* and the closely interwoven *political philosophy,* which study those political relations more broadly and more systematically.

More generally the *name* of a study applies also to the subject-matter or material of the study, and this inherent linguistic ambiguity, especially in English, sometimes proves

[5] An example of inconsistent usage occurs in a succession of treatises on *measurement,* theoretically and mathematically treated by English physicists and mathematicians. These we should expect to be termed *metrology.* But the older usage of this term was more often for descriptive and practical studies. The new writers therefore, to distinguish their work as more theoretic, have used the term that connotes the less theoretic, the practical, *measurement.*

indeed equivocal. Anatomy is the science of bodily structures and tissues, but the term *anatomy* is also figuratively synonymous with the concrete individual body; thus we speak of a man's "anatomy", meaning his body. Physiology is subject to similar concrete usage, when something "disturbs one's physiology." Psychology is the science of mind, but the term is sometimes applied to the workings of a particular mind in an actual situation. Chemistry, Physics, and even Mathematics partake, each in its special way, of this ambiguity of language, as when "chemistry" sometimes means chemical action. The geology of Europe is a field of study both in this country and abroad, but European geology of the geology of America is alien no less than American geology of the geology of Europe. History commonly denotes either the *historical course of events* in their temporal relations or the imperfect descriptive and narrative account of that course of events. The correlative *historical knowledge* of the course of events is, moreover, a different matter from the *historical account,* written or oral, and from the historical writing (historiography) of this; and this also is to be distinguished from *historiology,* the study of the method, verity, credibility, etc. of historical knowledge, of history as known and recounted, and of historiography.

CHAPTER XIV

THE MAIN DIVISIONS AND THE FUNDAMENTAL SCIENCES.

PRELIMINARY.

In the General Synopsis of the Classification of Knowledge at the end of the following chapter, the first of the four interrelated columns is headed Philosophy; and, as comprehending the whole range of knowledge, the several branches of philosophy parallel the respective *sciences* in the second column, to which the historical studies are also parallel in the third column, and the respective *applied sciences* and dependent technologies are again parallel in the fourth column. This is virtually a cross-classification, tho incomplete. Our point of view being dominantly that of natural science, the main divisions of our system [1] are likewise consistent with the fundamental sciences as graded by speciality, and the correlative, or parallel, branches of philosophy and of history are there accordingly placed under the respective main divisions, and so also are the more scientific branches of technology. This is the schematic statement for the most comprehensive and fundamental structure of our system.

That the logical classification of knowledge proceeds by division and subordination from general classes to more and more specific has been stated as one of the fundamental principles. The synthetic organization of knowledge on the other hand is, at least in some respects, a process reverse to that analytic ramification, but in other respects is merely the complementary *aspect* of a unitary development. The

[1] The author's system of classification is to be published in a separate volume in tabular form, as revised.

pedagogic order follows this synthetic process of organizing knowledge but is also consistent with the analytic order. It is with the structural classification of knowledge that we shall now have to deal more in detail, commencing with the most general and abstract philosophy and science, which purposes a comprehensive synthesis.

1. GENERAL PHILOSOPHY AND GENERAL SCIENCE.

The analogy of the tree of knowledge is appropriate to the relations of science and philosophy. The divisions of philosophy are outlined, and those of general science.

The analogy of the tree is so appropriate that we will retain it. Knowledge, rooted in reality, in experience, memory, and mental synthesis, expands in all directions, ramifying in diversified specialties, each branch a synthesis of concepts and each of these like a leaf assimilating new material. In the tissues and fibers of the trunk and branches the synthetic products of the boughs are built up; and in their unity inheres the strength that supports the expansive structure.

The mental processes are both analytic and synthetic. Thought may either pass outward thru the ramifications of analytic knowledge or inward to the sustaining and unifying core of the comprehensive and purposive Mind.

Regarding the analogy to a tree, the basic or central class is the most general, logically, and specialization proceeds upward and outward, whereas in a tabular classification the most general class usually is at the head and the gradation by speciality proceeds downwards.

When considering the "Point of View", we concluded that there are but three radically different views of the order of the sciences as grounded in the order of nature, the *naturalistic* view, the *historical* view, and the *psychological,* or epistemological, view. These differ mainly in that the naturalistic and historical views subordinate psychology to the science of man in his place in the order of nature, whereas the psychological view, regarding psychology as comprehensive and

as inseparable from epistemology, the philosophy of knowledge, and from logic, the science of valid thinking, places this basal group at the beginning of the series ahead of the natural sciences and the anthropologic studies.

The antithesis between the objective and the subjective leads in metaphysics to the distinction between the real and the conceptual, and in science to the contrast between the physical and the mental. But either of these realms may be objective to thought and to the intellect; the mental and conceptual may be objectified by the understanding, especially in the psychology of behavior and in the study of the "creations" of artistic imagination and expression.

Consistent with these considerations is the established logical division between the philosophy of knowledge and the philosophy of nature. The philosophy of knowledge comprises abstract epistemology, logic, methodology, and the philosophy of science. The philosophy of nature includes ontology (the abstract philosophy of existence and reality), cosmology (the abstract philosophy of the origin, development, constitution, and extension of the world, or universe), and the philosophical survey of the natural sciences.[2]

The philosophy of life comprehends the philosophy of biology, of anthropology, of human nature, and of society, law, and ethics. The philosophy of religion extends into the abstract studies of theology. These systems of abstract thought should arise from empirical, historical, and rational grounds in the sciences. But these philosophical divisions, proceeding from the subject-object antithesis, the distinction between the conceptual and the real, and the contrast between the physical and the mental, are divisions in the logical sense; they are not divisions for our system of classification. They are too broad, too abstruse, and too closely interwoven for classification with such systematic intent.

The logical division between the philosophy of knowledge and the philosophy of nature should not be mistaken for a partition of the fields of reality and knowledge into two separate domains; the tree of knowledge does not bifurcate in this division, the terms of which may be regarded as appropriate rather to two aspects of the unitary trunk or bole of the tree. Akin to this division, however, is the triadic division of the whole of philosophy into three fields, Logic, Physics, and Ethics, which in several forms was stated by the Stoic philosophers of ancient Greece. The prevalent modern division of the Mental Sciences from the Natural Sciences, or the Physical Sciences, has evidently derived from kindred origins, but is now more appropriate to developed science,

[2] The term *metaphysics*, sometimes restricted to the ontological branch and sometimes comprising also the epistemological branch, is too indefinite to be appropriate here.

tho the philosophy of knowledge and the philosophy of nature are counterparts or merging aspects of unitary general philosophy.

Here then, at the bole of our tree, at the basis of our system of knowledge, is placed the most general and abstract philosophy; here are assigned the disciplines that are essential to all critical and systematic knowledge and thought, scientific or philosophic, analytic or synthetic. In one sense these abstract and formal studies are primary or *propœdeutic;* in another sense they are not merely the first gateways but the ultimate avenues to the supreme comprehensive views. It is in the former sense that we may regard them as basic in the bole of our tree, as basic to the analytic and synthetic processes of the sciences. It is in the latter sense that we may regard those synthetic processes as combining in the trunk to give it the unity of philosophy.

This philosophical basis we will designate by the terms we have used to characterize it in the paragraph just above: General and Abstract Philosophy. It is to be distinguished from the first *main division* of our classification, which is designated as General Philosophy and General Science, which is more comprehensive, and of which this may be regarded as the first *division.* We are not unmindful of the stricture we made in a preceding chapter against the term *abstract* as applied to the division of the sciences. The term is used here merely for convenience and for lack of a better, more distinctive term. These studies, however, are not all purely abstract, nor all quite general, for there are many special minor offshoots from this trunk.

More comprehensive than the first division, the first *main division* of our classification comprises three divisions: (1) Philosophy, general and abstract, (2) Science, general and abstract, (3) Abstract Sciences and General Methods of Science. These are brought under the caption, General Philosophy and General Science.

The first division comprises General and Systematic Philosophy, Metaphysics, the abstract philosophy of Human Nature and Life,

and abstract Theology. Metaphysics, a term variously used, is here regarded as comprising both Ontology, the philosophy of existence and reality, and Epistemology, the philosophy of knowledge. Abstract Cosmology may be subsumed under Systematic Philosophy or under Ontology. Natural Theology and the Philosophy of Religion and of Ethics reach over into the scientific side of the tree in collocation with the Science of Religion and with Social Ethics. The Philosophy of Human Nature (formerly philosophical Anthropology) has for the most part been taken over by the science of Anthropology in its comprehensive scope, but partly also by the science of Psychology, while part of it remains in Philosophy, as does also part of the Philosophy of Life, the term Practical Philosophy being sometimes applied to this range of thought. The olden term Moral Philosophy covered a large part of the same field, but included also much of ethics and some of theology. In brief, all these branches of philosophy, old and new, have been closely interwoven. Many of these studies are by some writers called sciences. As we have said before, the distinction between a special science and a branch of philosophy is not definite. For convenience, however, this division is more briefly termed General Philosophy, or merely Philosophy.

The principles and philosophy of science are general and abstract. General Science, tho distinguishable, is not separable from Philosophy. Under the title *Grammar of Science* Karl Pearson implied nearly as much philosophy as Herbert Spencer implied of science in his *First Principles*. These scientific studies we shall term General Science, following the analogy of General Biology, General Sociology, etc. The term "General Science" is also often misapplied to a survey of the fields of science, especially in elementary text-books for high-school students. For this, however, it would be better in this classification to use the caption *General Survey,* or *Course, of Science,* or even Science Survey.

The third division, Abstract Sciences and General Methods of Science, is the subject of the following section.

General Philosophy and General Science we have treated as unitary in the bole and trunk of our tree of knowledge. But just above this bole and trunk the tree does bifurcate, the larger shaft giving off the successive branches of the several sciences in ascending gradation in speciality, and the somewhat smaller shaft beside it bearing the extensions of philosophy that overlap the corresponding scientific branches and historical and humanistic studies. This will be understood better on reference to the table at the end of this

chapter. Both these systems, tho very close at their origin, diverge as they branch upwards and outwards, but many of their branchlets are interlaced. Many sciences have their special philosophical extensions, and these are interfused with the special extensions of philosophy beyond the ranges of empirical science.[3] In the scientific branches the empirical and naturalistic elements predominate, producing abundant fruit, while the philosophical branches, being perhaps too much affected by metaphysical shadows, are for the present less vigorous in growth — yet with hope that in the future they will attain to equally splendid and bountiful development.

The reader, whether gentle or tough (to use an epithet applied by William James to the critical and scientific type of mind), may have become weary before this of the analogy of the tree and may now be glad to read that for the present we are nearly done with it. We beg of him, however, to take it for what it is worth; it may help to clarify the confusing relations between science and philosophy.

Regarding philosophy in its primal and in its highest stages as developmental to and synthetic to the sciences, Robert Flint in his admirable essay [4] began and concluded with the following sentences:

"The sciences are parts of a great whole, the members of a magnificent system. Each of them has manifold relations to every other. . . . Unless the intellectual universe be no real universe, but essentially a chaos, science must be general as well as special; or, in other words, there must be a science of the sciences — a science which determines the principles and conditions, the limits and relations, of the sciences. This science is philosophy. . . .

"Philosophy has always preceded what we would call science. Wherever there is earnest human thought as to truth and error, good and evil, right and wrong, there is something of the nature of philosophy, and as such it aspires to be coextensive with human knowledge, claims the right of criticising and testing all opinions, and hesitates not to raise and try to answer the most difficult and perplexing yet engrossing and important questions which can come

[3] *Cf.* Stumpf, *Op. cit.*, pp. 90–1.
[4] *Philosophy as Scientia Scientiarum,* Edinburgh, 1904, pp. 3 and 56.

before the human mind. Hence philosophy is rightly, and almost universally, regarded as the last and highest stage of human intelligence."

2. THE ABSTRACT SCIENCES AND GENERAL METHODS OF SCIENCE: LOGIC, MATHEMATICS, AND STATISTICS.

Logic and Mathematics are distinguished and defined. These, including the Science of Order, are sometimes termed the Formal Sciences. Statistics is a general method of science and belongs in this main division rather than in the Social Sciences.

Logic and Mathematics are the *abstract sciences,* as distinct from abstract philosophy and the abstract principles of general science. *Formal Sciences* they are often called, because they deal with forms and relations of knowledge or thought abstracted from all content of reality. Together they constitute a *Science of Order,* which, however, may extend to still other abstract studies. Logic is usually regarded as a branch of philosophy; and the close relation of philosophical to mathematical thought is often affirmed.[5]

So variously defined is Logic that this *formal* science seems almost protean. By Hegelians it is made no less comprehensive than metaphysics. As the science of knowledge it is regarded as comprising epistemology and much besides. Lotze, Sigwart, Bosanquet, and Croce have treated it as the *science of concepts.* Royce defined it as the "Science of Order",[6] which thus would include mathematics as its special development. This retaliates against Bertrand Russell and others who have urged that mathematics and logic are one "Science of Relations", and that logic is but an extension of mathematical principles. These logicians and logisticians would make too much either of logic or of mathematics. Both studies are at once abstract sciences of relations and general methods of science, logic extending knowledge by valid reasoning, mathematics by means of a more precise symbolical

[5] "Sans les mathématiques, on ne pénètre point au fond de la philosophie; sans la philosophie, on ne pénètre point au fond des mathématiques; sans les deux, on ne pénètre au fond de rien." — Leibniz, quoted by Laisant, in *La Mathématique,* Paris, 1898, p. 6.

[6] In *Encyclopedia of the Philosophical Sciences,* v. 1.

expression that is more plastic to relational operations. Logic treats of the relations of *verbal terms,* of concepts, *judgments,* and *propositions;* mathematics deals with *numeric* and spatial relations. Logic leads to *methodology,* mathematics culminates in *theory,* and concisely formulates theories as well as the relations involved.[7] Logic we will therefore define as the *abstract science of knowing and thinking thru valid reasoning,* Mathematics as the *abstract science of numeric and spatial relations.*

The priority and basic value of logic to mathematics is well expressed in the following passage from Jevons' *Principles of Science.*

"Nothing is more certain and accurate than logical truth. The laws of identity and difference are the tests of all that is true and certain throughout the range of thought, and mathematical reasoning is cogent only when it conforms to these conditions, of which logic is the first development. And, if it be erroneous to suppose that all certainty is mathematical, it is equally an error to imagine that all which is mathematical is certain. . . . But in no part of human thought can a reasoner cast himself free from the prior conditions of logical correctness. The mathematician is only strong and true as long as he is logical, and, if numbers rule the world, it is the laws of logic which rule number." [8]

Of other general methods of science the only one that needs especial mention here is Statistics, applicable in a wide range of sciences and resting on a mathematical theory. As such it should have place in this main division rather than under any division of special sciences, or the Social Sciences. Statistics is a method, inductive and deductive, for drawing generalizations and for verifying them. Dealing with individuals and particulars, as history does, and as description also does, statistics differs from both those methods in regarding the individual instances not as individuals but as instances, that is, members of a class. Statistics is thus a method of science, akin to classification, and applicable to any

[7] "Nicht in der Thatsache der Abstraction oder auch nur in dem grade demselben, sondern in ihrem *formalen* Charakter besteht daher die wesentliche Eigenthümlichkeit der Mathematik." — Wundt, *Ueber die Eintheilung der Wissenschaften,* p. 20.

[8] Vol. I, pp. 173–4.

science that draws inferences from classified individual instances. Dealing with numbers in various complicated relations, this method becomes mathematical and develops a mathematical theory.[9]

3. THE NATURAL SCIENCES.

The Natural Sciences are divided, tho not separated, from the Mental Sciences. The order of the special sciences is not very different in the psychological view. Even in the theistic view there would not be a dualistic separation of the human from the natural on the one hand and on the other hand from the divine.

From the antithesis of the physical to the mental arises, as we have seen, the principal division of the sciences into two broadly contrasted series, the Physical, or Natural, Sciences and the Psychological, or Mental, Sciences. The term *Mental Sciences* is more commonly accepted as comprising the Psychological Sciences, the Social Sciences, and all the cultural studies called the *Humanities*. As mind and mental products are distinctive of humanity, the mental sciences comprehensively are the anthropological sciences in the comprehensive scope of that term, but exclusive of Physical Anthropology, which is regarded as one of the natural sciences and which thus is the connecting link between the two series. It seems preferable, however, when the two series are unlinked in thought, to have this connecting link hang with the rest of the anthropological sciences and to use this latter term for the entire branch or series.[10] If mind be the essential, then mind reaches down into *animal behavior,* and psychology into biology, and that link too would be attached to the mental branch. This overlapping would be even more inconvenient than that of Physical Anthropolgy.

Thus we find that this division is, like the first division, a logical one, not really a separation. If there is no disconnection here, none indeed is more evident elsewhere in the

[9] Regarding the broad applicability of statistics the reader may consult Jones' *Logic,* p. 190, and Edman, *Human Traits,* pp. 405–6.

[10] *Cf.* Boaz, *Congress of Arts and Science, Proceedings,* v. 5, p. 472.

natural order of the sciences. The unbridged gap between the physical and the mental, or the physiological and the psychological, the theme of so many philosophic and poetic effusions, is, so far as scientific interest obtains, rationally bridged by the simple syllogistic fact that the human mind is in man and man is an animal, and all animals have their origin in nature. Mind has its roots deep in nature; memory is inchoate in the physical. The principles of biology and even of physics are valid at least in some actions and relations of mentality, and are likely to be found valid, so far as they are relevant, thruout the field of mentality.

From the naturalistic point of view the anthropological sciences are subordinate to the natural. From the psychological, or epistemological, point of view the natural sciences are, like all other products of mind, subordinate to Psychology. But, even so, descriptive and experimental psychology nevertheless depends upon several natural sciences, and the more special psychological and social sciences would in a secondary order be similarly subordinate to the natural sciences, and would so be arranged even by psychologists and by most philosophers. Then why should not general psychology too, as well as those closely related dependent studies, education, sociology, economics, linguistics, and æsthetics? The psychological view would thus either subordinate the naturalistic order of the sciences to epistemology or merely superpose that same order on the psychological basis.[11]

A Hindu myth conceived the Earth as resting upon the back of a universal tortoise floating in space. If those who held that belief could have seen underneath this conceptual turtle, they would doubtless have found that what had seemed to them the bed rock of existence was but a natural object of more or less familiar traits. To examine this cosmogonic basis, to recognize, to *realize* it, the Hindu believer should have naturalistically turned the turtle over on its

[11] This was stated more fully on pp. 241–3, in considering "The Point of View", and again on p. 253.

back — and of course the world with it. We must do the same with the epistemological view of the relation of psychology to the sciences. Objectively Psychology is subordinate to Biology and especially to Anthropology, and thus to the natural sciences. The world does not rest on the shoulders of Atlas, but Atlas, the man, bears his burden on the Earth. Man may be "the measure of all things" but he is not the container of all things.

The psychological view furthermore would paradoxically lead to the inconsistent separation of the general and explanatory part of psychology from its special and descriptive studies. This would be even worse than the separation of psychology entire as a science from epistemology and logic as branches of philosophy. For the trend of modern psychology is positively averse to "metaphysics". Scientists avowedly are resolved to exclude that kind of philosophy.

In stating our "Point of View" we intimated that some accommodation of our naturalistic view to the psychological view would be effected where feasible. But of course with the tree of knowledge in reality before our vision we cannot expect to look at it both ways at once. That were not possible even if it were a metaphysical tree in the fourth dimension. We have recognized this limitation, but first from the epistemological side we have viewed the Philosophy of Knowledge and Abstract Science and now on the naturalistic side we are to survey the special sciences and the correlative extensions of special philosophy.

There is no disconnection then between the Natural Sciences and the Anthropological Sciences, or the Psychological, or Mental, Sciences. In the naturalistic view all that is human is in the broad sense natural. Even in the theistic view, man, as the child of God, as the creature infused with the Divine, as God's especial means of self-realization, would still subsist in nature as a part of nature; and, moreover, man's higher spiritual nature, as derived from God, would not be external to Nature; for God is either immanent in Nature

or pervasive of Nature, developing and realizing in this world the divine higher Nature of creative energy, controlling power, evolving purpose, comprehensive intelligence, and spiritual love. These are the highest attributes which we conceive as Divine. The highest *reality* that the human intellect has revealed is the order of nature and the universe. It would seem as inconsistent with the theistic view to postulate a dualism in which the human is separate from the Divine as it is inconsistent with the naturalistic view to separate the human from the natural.

4. THE PHYSICAL SCIENCES.

This group, centered about the concepts of matter and energy, is distinguished from the Biological Sciences, which are centered about the concept of life. Physics and Chemistry are defined. Physics may be treated under three captions: (1) Mechanics, (2) Matter, Energy, and Radiation, (3) Applied Physics. Also Special Physics is distinguished from General Physics. These branches are reduced to a tabular synopsis. Composite and applied physical sciences are then mentioned, especially Astronomy, Geology, and Geography.

The Natural Sciences, exclusive of the Anthropological, are customarily divided again into two great branches, the Physical Sciences and the Biological Sciences.[12] It were more accurate to say that the latter group is differentiated from the former and centered about the concept of life. We readily distinguish in common knowledge between living and inanimate bodies, and the distinction is dominant in our thoughts and conduct; it has become established in scientific thought; but on closer scrutiny we find that here again there is no absolute division.

It is difficult to define the concept of life. Is it merely a matter of definition? Are certain properties and functions merely brought under a definition by specified character-

[12] At the beginning of the preceding section the term Physical Sciences, as alternative to Natural Sciences, was opposed to the term Mental Sciences, or Psychological Sciences. This broader use of the term Physical will be mentioned more especially on pp. 274–5. There are three broad divisions to be considered here, that of Biological from Physical, that of Psychological from Physical, and that of Mental from Natural.

istics; or is there an intrinsic causal definition? First let us consider what physical science comprehends.

Physics has for its central concept the general properties and actions of particles of matter and of aggregates or organizations of these. It treats them as abstracted from the specific properties and qualities by which concrete material substances are distinguished in Chemistry. *Matter* is implied, tho not fully explained, as the substance in which the properties and actions inhere. *Energy* is implied as that which causes or enters into actions, forces, or work, and reissues from them. Matter in general is that which subsists in and is substantial to all concrete bodies and specific materials, properties, forms, changes, and products. The concepts of matter and energy arise from generalizations of the properties and the forces. The concept of matter has empirical grounding, and, in the realistic view, it is indispensable as that in which energy subsists and is manifest. To deny the reality of matter would leave but two ultimate realities, or substances, Energy and Mind, or God. The doctrine that makes the former the whole is Energetics. That Mind, or God, is the whole is the doctrine of Absolute Idealism. That there is in Nature, in Energy, or in Mind, nothing but matter in action is the doctrine of Materialism, which must therefore imply that matter is self-activating, or that action is without cause or purpose. Matter, Energy, Mind, this trinity may ultimately reduce to a unity, which might then be named by any of these three terms, according to the point of view. But realistic philosophy at present distinguishes the three concepts as differing at least in connotation and in implication. Mind is that which conceives, purposes, and activates. Energy is that which is manifest in actions, forces, and effects. Matter is that which is substantial to properties and substantive to actions. Physical science, however, entertains the duality of matter and energy, referring to Philosophy the questions of existence, of substance, and of cause.

Physics is definable as *the science of the properties of matter and the actions of energy*. It is a *general* science, of which the principles and methods are applicable thruout the wide range not only of the physical but, more broadly, of the natural sciences; but it is also *special* in its branches, which are distinguished from those of chemistry, and from those of astronomy, in that special physics studies the special actions and properties abstracted from the specific substances and the concrete bodies that are the subject-matter of those subordinate physical sciences.

Chemistry is definable as *the science of material substances, of their specific properties, composition, constitution, changes, and combinations, and of the special physical actions involved in these properties and changes*. Chemical substances are analyzed into specific physical properties, and are subject to physical tests; but chemical principles are not so general as to apply to the whole range of physical actions. Chemistry is more specific and deals more with the concrete. From the empirical point of view Physics usually deals with properties singly, or severally, while Chemistry usually deals with properties combined in materials, or substances.[13]

"We can, for example, make any such body hot or cold, we can electrify it, we can illuminate it with red or blue light, we can magnetize it, etc. In all these cases we are dealing with arbitrary properties, and their study belongs to Physics, and not directly to Chemistry. But the metallic nature of silver, its good conductivity for heat and electricity, its stability in air and at high temperatures, its solubility in nitric acid, — these we cannot take away singly or change one at a time. The study of such properties belongs to Chemistry.

". . . Bodies which are considered only in connection with their specific properties are called *substances*, and they form the materials for the study of Chemistry." [14]

[13] "Was wir *einen* Körper nennen ist eben ein *Complex* von Eigenschaften, die in verscheidene Sinnesgebiete fallen, und die "Materie" ist eben *nur* die Vorstellung des *Zusammenhanges* dieses Complexes. Bei physikalischen Vorgängen ändert sich rein oder doch vorzugsweise *eine* Eigenschaft des Complexes, bei chemischen Vorgängen der *ganze* Complex." — Mach, *Principien der Wärmelehre*, Leipzig, 1900, p. 335.

[14] Ostwald, *Fundamental Principles of Chemistry*, p. 4.

"Natural changes have long been grouped into physical and chemical; in the former the composition of matter usually plays an unimportant part, whereas in the latter it is the chief object of consideration. From the point of view of molecular theory a physical process is one in which the molecules remain intact, while a chemical process is one in which their composition is altered." [15]

Physical Chemistry applies physical principles, laws, and data to the study of specific chemical properties and changes.[16] The interests and objects are chemical rather than physical, and so Physical Chemistry is usually regarded as a branch of chemical science. As a branch of Chemistry, it comprises, besides special studies, much that is theoretical; and indeed the term Physical Chemistry tends in recent usage to become coëxtensive with Theoretical Chemistry. Of course it is understood that there is theory in other branches of chemistry, but most of this theory too is found to be physical. This recalls our stricture regarding the use of the term *theoretical* as a basis for division in the sciences. It may be that the same may be said of the term *physical:* it too is pervasive.

Physics is the most general of the natural sciences and the most broadly applicable. Its unitary nature appears in a more comprehensive definition than that given above, such as the following: Physics is the science of the actions, transference, transformations, and applications of forces, effecting or producing changes or motions in bodies or particles of matter or aggregates, composites, or organizations of these. These actions are abstracted from the specific properties of the concrete material substances in which they take place, and only those properties are regarded which are directly involved in the actions studied.

Tho unitary in its fundamentals, Physics comprises very diversified subject-matter disposable under three main captions, or

[15] Nernst, *Theoretical Chemistry,* 5th, revised edition, 1923, p. 40.

[16] ". . . . where the laws or generalizations regarding properties of matter depend not merely on the masses or rates of motion of the objects considered, but also on their composition and chemical nature, their consideration falls under the heading "Physical Chemisty". — Ramsay, "Introduction to the Study of Physical Chemistry" in Young's *Stoichiometry,* p. xiv.

branches. The triune, or triangular, content appears in that all physical data may be analyzed in terms of *mechanical* forces, or *dynamically;* secondly, they may be described, or "explained," as actions, or effects of actions of energy in particles of matter,, that is, as *kinetic,* or *energetic;* thirdly, they may be studied with purpose to *apply* those forces *technically* to work, to produce mechanical or motive powers, or to control the terrestrial physical powers of nature. The three main captions accordingly are: (1) Mechanics, (2) Matter, Energy, and Radiation, and (3) Applied Physics.

Mechanics is the most abstract and general branch, or subscience, of Physics, and comprises Kinematics, the purely abstract study of motion, and Dynamics, the abstract study of forces and actions, of which Kinetics is the subordinate branch for forces in action, and Statics the special branch for forces in equilibrium.

General Physics includes, besides general Mechanics, the general studies of Matter, Energy, and Radiation, and the Properties and States of Matter in general, in all materials and all bodies and in the broadest range of relations. Physics is the general science of Matter, of Energy, and of Radiation. To this science abstract Mechanics is propædeutic. The existence of atoms, electrons, and molecules is inferred; energy is postulated, and the transference of radiant energy, or radiant matter, is comprehended by the theories of energetics, of electronics, of electrodynamics, and of thermodynamics. These theories, however, are all generalized and of general application, and therefore may be subsumed under General Physics.

Special Physics is of course a relative term. Here it is to comprise the more special studies of Special States of Matter and Special Actions of Energy, and also Special Extensions of Mechanics and Special Dynamics, and Special Applications of Mechanics, The principles of dynamics and kinetics are manifest in more specific and analytic actions and relations, properties and quantitative determinations. These various actions are but forms, or transformations, of the unitary Energy inherent in the cosmic Substance, or Matter.

Special Physics is difficult to classify because its fields are not clearly delimited as are the special branches of the more concrete natural sciences. "Molecular Physics" and the studies of special properties and "states" of matter have customarily been distinguished from the studies of radiation, formerly termed "Æther Physics". But the æther is very hypothetical, and, as conceived, has contradictory properties; and it is discredited in modern physical science more or less positively. These contradictions may, however, sometime be reconciled by superior comprehension of the quantitative relations involved.

The branches of Special Physics may also be classified under the

triple term Matter, Energy, and Radiation. Traditionally, however, the treatises and text-books have treated groups of phenomena, actions, properties, and relations, under the familiar terms: Sound, Heat, Light, Electricity, etc. These studies cannot now be so separated; yet we may for convenience retain these captions to designate more or less distinct branches. Sound is virtually a special branch of Dynamics. Heat is both a state, or a property, of matter, and also a mode of energy, and as such it is radiant. In the phenomena of Light similar properties, states, and radiations are active, but in a higher range of vibration. All the special radiations issue from specific states or properties of matter and from specific actions that, according to present theories, are atomic, or electronic, and dynamic. Electrical phenomena are special manifestations of these same or of kindred properties, actions, and relations.

The foregoing divisions and subordinations in physical science may be represented in a tabular synopsis such as the following. It is not our purpose here to go into the ramifications of special classification. That belongs to subsequent parts of this work. A tabular view for Physics is given here, however, because the science is so general, so unitary, and so important.

Physics, General.

- Mechanics.
  - Kinematics.
  - Dynamics.
- Matter, Energy, and Radiation.
  - Constitution of Matter and Relations to Energy.
    - Atoms, Electrons, Molecules.
    - Properties and States of Matter in general.
  - Energy, Energetics, Kinetic Theory.
  - Radiation in general.
- Special Physics: *special properties and states of matter and actions of energy.*
  - Heat, and Thermodynamics (including Radiant Heat).
  - Radiation and Radioactivity, Special.
    - Light (Visible radiation).
    - Electricity and Magnetism.
  - Special Dynamic Actions.
    - Sound.
    - Hydrodynamics.
    - Pneumatics and Aerodynamics.

Special in another sense are the branches of physical science that study special kinds of physical objects, crystals, rocks, mountains, clouds, meteors, planets, stars, etc. In such concrete studies physical and chemical properties and relations are usually involved together, and with the methods of those two general sciences are

combined the more abstract methods of mathematics and statistics. The most general of these *composite sciences* is Astronomy, the science of massive bodies in space, their constitutions, history, and movements. Of Geology, the science of the Earth, its constitution and history, the branches are Physical, Chemical, Dynamical, Tectonic, or Structural, Stratigraphic, Physiographic, Historical, Paleontological, Geographical, and Economic. Mineralogy, with Crystallography, belong rather with Chemistry. Closely related to Physiographic Geology, or Physiography, is Physical Geography, also called Physiography; and subordinate to this are Meteorology, Hydrology, and Climatology. Biogeography, Phytogeography, Zoögeography, and Anthropogeography deal with the forms and relations of living organisms, of plants, of animals, and of mankind, as depending on and reacting on physiographic conditions, and these branches should be subordinated under the respective sciences of Biology, Botany, Zoölogy, and Anthropology.

The Geological Sciences, sometimes called the Earth Sciences, comprise Geology, the several branches of scientific Geography (including Geodesy), Geognosy, and Natural History (descriptive science distinct from Natural Science in the broad sense and from History of Mankind, anthropological, ethnical, and social-political.

5. THE BIOLOGICAL SCIENCES.

Biology is defined. The characteristics of life are gleaned from sentences of leading biologists. The relations of the biological to the physico-chemical are considered. Vitalism is not scientifically established. Biology is divided into Morphology and Physiology. The subdivisions may diagrammatically be reduced to a cross-classification, but they should have a three-dimensional structure. The Biological Sciences virtually comprise the Psychological and the Social, according to the principles of gradation in speciality and successive comprehension in the order of generality.

It may be said that there is but one biological science, the comprehensive science of Biology, the science of life in all its forms and manifestations, the third of the fundamental sciences, with Physics and Chemistry completing the triad of fundamental natural sciences. But, as one of the distinct "special" sciences, Biology is not so comprehensive in scope. It expressly leaves the higher mental developments to the subsequent psychological and social sciences. Biology is the science of *life* and of *organisms,* of the various *forms* and *structures* of organic bodies, and of their origin, development, organization, evolution, and relations, their functions, actions, and behavior.

What is life? What distinguishes living substance from inanimate matter? For naïve minds it is merely motion, whether of bodies or limbs, of breathing or merely of cilia. But lifeless filaments may sway in the currents of a brook or vibrate to a passing breeze, while living bodies may be apparently motionless. The motion that is essential to living tissue is that of nutritive material in the functions of organs, whether stationary or motile, of ingestion and egestion. That life is characterized neither by motion nor by assimilation alone was plainly shown in Sir Edward Schäfer's presidential address before the British Association.[17]

One of the most important effects of ingestion is *growth.* But a crystal grows by accretion from its magma, from self-acquired materials. "Self-acquisition of nutrition" was Ostwald's qualification for living organisms.[18]

Lotka in his *Elements of Physical Biology,* p. 10, in discussing definitions of life, says: "It has similarly been urged, as a distinction between the growth of a crystal and that of an organism, that the former will grow only in a supersaturated solution of its own substance, while the latter extracts from an unsaturated solution the substance needed for its anabolism."

Mere increase is not the characteristic of organisms, but *development.* The crystal, once formed, is stable, whereas the organism is subject to change; the matrials flow thru its organs, its tissues; the life that has flowed in flows out. Proteins, carbohydrates, and fats are chemically derivatives of the aliphatic series of carbon compounds and have molecules constituted of atoms in *open chains,* whereas *closed,* relatively stable rings, or *cyclic* atoms constitute the molecules of the aromatic series of carbon compounds, as in cellulose and in coal.[19] According to Schäfer and Loeb, oxidation is the characteristic of life; [20] according to Verworn, irritability is characteristic of protoplasm, and response to stimuli is characteristic of organisms.[21] But furthermore organisms give rise to new organisms, with evolving complexity of form and function. Development and reproduction are significant principles of organic bodies and of life. To recapitulate, the essentials of life are nutrition, oxidation, development, sensitiveness, response, activity, and reproduction.

[17] Reprinted in *Nature* for Sept. 5, 1912, p. 8.

[18] *Natural Philosophy,* tr. by Seltzer, p. 165.

[19] The significance of this contrast has been touched upon by H. H. Newman in his chapter on "The Nature and Origin of Life" in *The Nature of the World and of Man,* edited by him, p. 167.

[20] "Scientifically, however, individual life 'begins with the acceleration of oxidation in the egg,' and 'ends with the cessation of oxidation in the body'. The problem of the beginning and end of individual life is thus physico-chemically clear, ..." Schäfer, quoting Loeb, in *Nature,* Nov. 21, 1912, p. 327.

[21] Herbert Spencer expressed the same general truth in his definition: "The continuous adjustment of internal relations to external relations."

The living is to be distinguished from the organic, for that may be dead. Seasoned wood, coal, and dried tea-leaves are spoken of as organic products. Are they still organic? Does the organic, which develops out of the inorganic, return into the inorganic? By chemical and by physical change it does — in the ashes of wood, in the dust of the dead.

These questions concern us here because Biology, especially in its physiological branch, reaches down into "organic" chemistry (so miscalled), and the Biological Sciences comprise Paleontology, the sub-science of fossil forms in relation to biological and geological history.

What do we mean by *organic* and *organism?* Little need be added here to what has been said on *organization* in Chapter IV. By *organism* we mean not merely an organization of parts or organs but of *vital* tissues and *functioning* organs, or of those that have been such and therefore are still regarded as organic. A dead organism, preserved in its integrity as a biological specimen, is still an organism. A separate organ, or part, or tissue, or a fossil of what *was* an organism, is still *organic*. The unit of organic structure is the cell. Cells multiply to form tissues, and from these there develop organs, those that are closely related constituting an organ-system, or organism, sometimes comparatively simple and sometimes very complex, but possessing individuality. An organism is a product of development by growth and differentiation of tissues and organs, with correlative specialization of functions.

Whether this development is wholly determined by inherent genetic causes and adaptive tendencies or by external agencies or supernatural potencies — this is the great question of *ontogenesis and evolution versus special creation,* the question that has measured the divergence between scientific and religious thought in the past. Those views, however, are now convergent, for both those theories involve converging arguments of *purpose,* and both these doctrines imply *determinism,* postulating that the sequences are *determined* by

consistent causation, however obscure or imperceptible. If the determinative causes are continuously effectual or evidently *efficient* in a definite direction, that causality implies a pervasive or an immanent Purpose which is at least directive. If the purpose is supposed to have been preconceived, or to be unconditioned by temporality, and to be realizable in the *end* of that purpose, the causation is termed *teleological,* and that end or purpose is termed its *final* cause, which is supposed to affect the antecedent states, or to be effectual continuously thruout the process.

There may be imperceptible stimuli, external or internal, from subtle physical actions in surpassingly complex relations, which, if they could be brought within the range of perceptual analysis, might account for the hitherto inexplicable reactions and interactions of ever mysterious life. Or on the other hand those subtle determinations may result from immaterial or spiritual agencies or powers of control, of which some minds believe they have intuitive knowledge, as minds know Mind. Whether internally or externally, physically or spiritually determined, the development of organisms, as indeed of all nature, is, it is reasonable to believe, purposive.

Life plainly has a physico-chemical grounding; it subsists in chemical substances; it functions thru physical actions. Physics and chemistry continually reveal hitherto undiscovered actions and relations. Are vital activities activated by some energy or agent that is not resolvable into the physico-chemical? To postulate a distinct *vitality* is but to answer this question with another term for a mysterious *what* that may indeed be found to be some hitherto undiscovered physical action. To attempt to define such a conception is usually to combine what is now known of the so-called vital phenomena with some newly imagined physical analogy.

"The advocates of vitalism claim only that certain vital phenomena are not *fully explicable* in physicochemical terms. They have no alternative explanation to offer — only the name *Ente-*

lechy, which serves to label the unsolved problems but does not advance one whit our understanding of them.

"The organic processes are every year brought more and more within the domain of physics and chemistry. Unless some new force is definitely discovered, should not the scientist assume that the unexplained processes harmonize with those already worked out? Vitalism is a *possible* hypothesis, but it is not scientifically acceptable, for it stands without direct support." [22]

One of the clearest statements on this side of the argument was made in an address on "The Relation of Biology to Physics" by Professor T. H. Morgan, reprinted in *Science,* March 4, 1927. See especially pp. 217–18.

The vitalistic inferences are very uncertain and the theories of vitalism are hazy. As yet no vitalistic philosopher, not even Driesch with his "entelechy",[23] has convincingly established a theory of immaterial, or spiritual, determination of vital actions. None has conceived the inconceivable save in the imaginary. The physicist makes no explicit claim to have solved the secrets of vitality, of development, of response, of memory; he simply investigates data on the borders of these problems; and, while the physicist has discovered many marvels, the vitalist has discovered nothing but new questions and has proposed little besides new terms. These considerations lead us to entertain the theory that the vital has originated from and is continuous with, as it evidently is grounded in, the physical. To affirm this we are furthermore led by our rational belief in the unity of nature.

This is not mechanistic, for physics is not confined to mechanics; nor is it materialism, for physical actions may indeed not be limited to the material. But what do we know of the immaterial? What seems less material than radiant light, traversing vast, super-conceptual spaces with verit-

[22] H. C. Warren, *Psychological Review,* v. 21, p. 88.

[23] "Entelechy — not being an extensive but an intensive manifoldness — is neither a kind of energy nor dependent on any chemical material; more than that, it is neither causality nor substance in the true sense of these words. But entelechy is a factor of nature, tho it only relates to nature in space and is not itself anywhere in space." — Driesch, *Science and Philosophy of the Organism,* v. 2, p. 338.

able but hyper-conceptual speed? [24] What seems less material than the atom of matter itself, an imperceptible system complex with infinitesimal elements in unimaginably rapid and complicated motions and compact with proportionately immense energies? Are these electrons and ions, *quanta* and oscillations material or immaterial? In view of these questions how can a philosopher deny the possible extension of physical actions into organic and even into mental activities? The true scientist declines to be dogmatic one way or the other while knowledge of matter and energy are so imperfect. Matter and energy are always bound together in physical actions, and energy is transferred from one form to another; the rational conclusion then is that any *vital* activity dependent on a distinct form of energy termed *vitalistic* should be *transformable* into other forms of energy termed *physical* and would also be *derivative* from such physical forms of energy. Are not such transformations amply evident in vital phenomena?

In the highly estimable opinion of an eminent biologist, Professor Conklin: "It seems unfortunate that those who are concerned chiefly to prove that no scientific or mechanistic explanation is ever complete should thus contrast the phenomena of the living and the non-living worlds and attempt to build up a distinction that is not only indefensible but is worse than useless, since it logically leads to the view that the essential factors of biology, as contrasted with all other sciences, are forever beyond the reach of scientific investigation. Both animate and inanimate nature are full of mysteries, and none of our so-called 'explanations' ever reach to the heart of things, but it is evident that both the living and the lifeless belong to the same universe." [25]

Relevant to this question of the extension of physics to comprehend the vital actions and changes, is the older usage of the term *physics* as derived from the Greek φύσις, the equivalent of the Latin *natura* and of the English *nature*. The terms Natural Sciences and Physical Sciences are still

[24] Professor P. W. Bridgman thinks that Physics had better give up the concept of light as corpuscular and motional. *The Logic of Physics*, pp. 150–166.

[25] *The Direction of Human Evolution*, p. 190.

often used synonymously. This view of the close relation and continuity of the Biological with the Physical is not degrading to Life; it is but placing it in its proper relation to Nature and to the Natural Order, and ascribing to Physics its broader, basic relation to all the sciences of Nature; and at the same time it is recognizing that with respect to this relation the Physical Sciences may be regarded as comprehending the Biological Sciences.

Biology has two interrelated main branches, the one treating of life and of the functions of organisms and their activities, abstracted from their forms and kinds, and the other dealing with the forms, or structures, and kinds, of organs and organisms, whether or not in relation to the correlative functions and activities of life. The former branch comprises General Biology and General Physiology; the latter branch is termed Morphology.[26]

In accordance with the principles of the subordination of the specific to the generic and of gradation in speciality, the physiological branch ramifies from the general study of the principles, properties, and conditions of life to more and more special studies: the theoretical inquiry into the origin of life and organisms (biogenesis); the study of cells (Cytology), from which tissues and organs develop; the sub-science of the functions and actions of tissues, organs, and organisms (Physiology); and more specially the investigation of the relations of organisms to the conditions of their environments and their reactions to these (Ecology); and, still more specially, their ecologic habits and *behavior* and their *physiographic adaptation.*

These studies are closely interwoven with those of the morphological branch. Cytology merges into Ontogeny, the descriptive and theoretical study of the origin and development of individual organisms. This leads to the study of the development of embryonic forms (Embryogeny) and the more descriptive and comparative study of Embryology. Anatomy, the more general subscience, analytical, descriptive, and comparative, of the structures and forms or organisms and their organs (organography), reaches down analytically into Cytology thru Histology, the study of tis-

[26] A few writers have thought to extend Morphology, as the general science of forms, into the fields of the inorganic, crystals, molecules, and astronomic bodies, and especially physical and stereochemical forms; but we shall not follow them here.

sues. Cytology and Ontogeny involve physiology as well as histology and morphology; and Genetics (in the broader sense), the study of the origin, heredity, variation, and evolution of organic forms and kinds, implies not only morphology and ontogeny but also physiology and ecology and especially *phylogeny,* the evolution of the manifold kinds of organisms in temporal or historical sequence and in relation to the ecologic conditions and the several causal "factors". Phylogeny depends largely on Paleontology, the study of fossil organic remains, with regard to historical geology.

Besides these general, theoretical, comparative, and historical studies, there are descriptive studies, morphological and also physiological, of the manifold forms and kinds as classified systematically. These studies may be subsumed under two branches termed Descriptive and Systematic Botany and Descriptive and Systematic Zoölogy. In their lowest ranges these two branches merge in the study of primitive and simple organisms, termed *protistology.* Morphology may thus be surveyed from three aspects, the theoretical, the historical, and the classificatory. These interlocking branches may indeed be regarded as three-dimensional.

Botany and Zoölogy moreover are not all morphological, but customarily include their own special physiological studies, of which some captions have, however, been appropriated to Biology as the comprehensive science. Botany as a sub-science, has usually been subdivided into Anatomy, Organography, Physiology of Plants, Ecology, and Systematic Botany. Zoölogy has similarly been subdivided into Comparative Anatomy, Physiology, Ecology, and Systematic Zoölogy. More specially there may be similar subdivisions of the study of a phylum or class or family of plants or of animals, e.g. the comparative anatomy of the *Vertebrata,* the ecology of the *Bryophyta,* the phylogeny of the *Reptilia.*

These interrelations may be represented, tho inadequately, by a cross-classification. The manifold forms of living things all embody the properties of life and express the principles of biology. Thruout the entire classificatory series of plants and animals morphology is correlated with and crossed by physiology. It is, however, no simple cross-classification that is here involved but a three-dimensional ramification of complex interrelated studies.

The term *Biological Sciences* is in one sense applicable to this complex system of studies centered about Biology and comprising the sub-sciences of Botany and Zoölogy. But more extensively the term Biological Sciences may be regarded as comprehensive of all the sciences of life and life activities: the Anthropological, the Psychological, and the

Social Sciences, and even Ethics and Æsthetics, — that is, all the sciences that are subsequent in the order of gradation by speciality. This statement is similar to that made above for Physics as a fundamental science and the Physical Sciences regarded comprehensively. Similar statements may be made for successively subordinate groups of sciences. Each more general group, centered about its distinct fundamental science and thus occupying a definite place in the order, may be regarded as comprehensive of those groups that follow in the order of gradation by speciality. And conversely, the special sciences are dependent on and are successively comprised by the more and more general in the order of generality.

CHAPTER XV

THE STUDIES OF HUMAN NATURE, LIFE, AND ART.

1. THE ANTHROPOLOGICAL AND THE PSYCHOLOGICAL SCIENCES.

The relations of physical Anthropology to morphology and of psychology to physiology are stated, and the relations of hygiene and medical science; then the relations of the history of mankind and the social sciences to the genetic and historical and to the ecological branch of biological science; also the geographical relations. Education is regarded in relation to psychological science. The relation of Psychology to Philosophy is humanly less important than its relations to Physiology and Sociology.

We have found that Biology branches three-dimensionally into physiological, morphological, and genetic studies. The resulting difficulty in classification will extend in certain respects also into the succeeding groups of sciences. From the morphological branch arises Anthropology, Physical and Racial; from the physiological branch the science of Psychology; from the genetic and historical branch develop Ethnology, History of Mankind, Sociology, and the Humanities.

Which of these three branches shall we take up first? In considering the division of the Natural Sciences we decided to pass naturalistically from the biological to the anthropological as the next in speciality. Man is morphologically rooted in the zoölogical, and *Homo* is but the highest of the zoölogical series. While Psychology, as a general and fundamental science, also extends downwards in this range, it is in man that the science is centered, and it is the central interest that, as we have stated before, determines the place of a science in the series. Psychology is thus more special than Anthropology as broadly the science of humanity. The mentality, or psychology, of animals should then be sub-

sumed under Zoölogy. The Anthropological Sciences are accordingly regarded as more comprehensive than the Psychological Sciences. So important to humanistic views is their central interest in humanity, that, if there is to be a principal division of the sciences, this place seems the most feasible, dividing the Natural Sciences from the Anthropological, or Human, Sciences, in the broadest sense of this term. The Anthropological Sciences thus comprise Physical Anthropology, the Medical Sciences and Hygiene, Psychology and Education, Sociology, Ethnology, and Ethnic (or Culture) Anthropology,[1] Anthropogeography, History (ethnic, social, and political), Ethics and Religion, Political Science, Economics, and other related studies, also Æsthetics and the Arts of human industry, expression, and communication, including Linguistics.[2]

The name *Anthropology* is sometimes used as embracing nearly this same range of studies.[3] So variously is the name applied that we take occasion to define it for the purposes of our classification as the science of man, of human nature in its entirety, and of the products of humanity, but descriptive of characters, types, and differences, rather than explanatory or philosophic. Anthropology comprises three main branches. Physical Anthropology deals with the body of mankind, including Anatomy, Physiology, Hygiene, Pathology, Teratology, and Anthropometry, and the study of individual differences and the physical types of men. It also studies the genetic and zoölogical relations in its sub-branches Anthropogeny and Zoölogical, or Taxonomic, Anthropology. The latter sub-branch passes into the study of the races and varieties of mankind, formerly called Ethnology but now preferably

[1] The term Cultural Anthropology is superseding the older form Culture Anthropology. It is indeed in analogy to the commoner form for such terms; but on the other hand it is too suggestive of the common adjective use.

[2] "The study of language is a division of the general science of anthropology, and is akin to all the rest in respect to its objects and its methods." — W. D. Whitney, in *Encyclopædia Britannica,* XI ed., v. 21, p. 415.

[3] For the distinction between Anthropology and the Anthropological Sciences see a paragraph on p. 203.

Racial Anthropology.[4] The second main branch of Anthropology studies the mind of man from the point of view of development and differences, racial and individual, and is termed Anthropological Psychology. It is also a branch of Psychology. The third branch surveys the cultural and social aspects of humanity. Of that we shall treat more particularly in the next section.

From the fundamental science of Psychology, centered in the psychology of humanity, are developed the Psychological Sciences, including: Anthropological and Racial Psychology, mainly the study of differences and types; Social Psychology, the counterpart of psychological sociology; Psychopathology and Psychiatry; Education, a sub-science depending largely on applied psychology; and Psychology applied to other studies.

Education, as the training and developing of mind and of mental abilities, is inseparable from psychology on the one hand and from sociology on the other. It develops the mind of the individual and adapts it to its natural and social environment, making it social, at least in some measure. Its special branch, Educational Psychology, is psychology applied to educational theory and method. Another special branch, Educational Sociology, is a survey of the social relations and of social psychology in order to provide better education for society. It seems more consistent to subordinate Education to Psychology than to place it under Sociology, as some classifications do, separating it from Psychology by sociological and ethnological studies that have little relation to Education.

There is ample scientific and philosophic justification for subordinating Psychology to the Biological, or to the Natural, Sciences, as we maintained in the second section of the preceding chapter. The philosophy of mind may, however, be linked with the philosophy of knowledge, if philosophers de-

[4] The uncertainty of racial distinctions and the complexity and impermanence of varietal traits and types have diminished the interest in that field, and the ethnologists have been drawn more to the study of the cultural t aits and developments of humanity.

sire to separate it from the science of psychology. But few modern psychologists would prefer that allocation, and few scientific philosophers.

2. THE SOCIAL SCIENCES.

The scope of this group is outlined. Sociology, the last of the fundamental sciences, Ethnology, Ethnic Anthropology, Ethnography, and Anthropogeography are differentiated and defined, and History and the Auxiliary Sciences are considered.

This term is usually restricted to a group of sciences, which, tho mainly descriptive, attain to considerable generalization, abstraction, and law, — namely, Sociology, Social Ethics, Political Science, Jurisprudence, and Economics. But the range of the division may on sound argument be regarded as comprising Ethnology, Folk-lore, and Religion, also Linguistics (as language is a means of social communication), and even Art and Literature, as social products and expressions. These arts, however, stand apart as superior products of the mind; and, as they are usually studied without special regard to sociological principles, these studies are not to be termed *social sciences* in the special sense.

Sociology, the most general and comprehensive of the social sciences, has, despite pronounced strictures, gained recognition as a fundamental science, — the last of these in the series of gradation by speciality. Like the other fundamental sciences, it is general in extension, covering all the fields of social science in a general way from its central viewpoint. Sociology was defined by Ratzenhofer as "the science of the reciprocal relationships of human beings".[5] But as a general science it comprises social relations and behavior thruout the world, whether of insects or of mammals.[6] Rooted in biology and anthropology, its place, however, is that of a more

[5] *Congress of Arts and Science*, v. 5, p. 815.

[6] "Sociology is the science of mental phenomena in some of their higher complications and reactions, as presented by a plural number of interacting minds, and of the constructive evolution of a social medium, through which the adaptations of life and its environment become reciprocal." — Giddings, *Inductive Sociology*, p. 7.

special science, subordinate to Psychology. Like Psychology, Sociology is regarded as predominantly centered in humanity. It is chiefly concerned with voluntary association of individuals in social groups, communities, and classes, and the organization of social, political, and ethical institutions. Certain biological and ethnical elements condition the social organization; they are basic, while the mental, volitional, and communal elements are dominant.

Ethnology is the comparative and explanatory science of racial, cultural, and artistic elements and products, comprising both the study of ethnic groups with regard to their origin, differentiation, distribution, and development, and also the general study of human culture in ethnic materials. The term *ethnology* has been used and defined so variously that some scientists avoid it, preferring the term *ethnography,* or the term *ethnic anthropology* (or *culture anthropology*), and the term *racial anthropology*. The confusing relations of these studies and their overlapping branches, whether of anthropology, of ethnology, or of sociology, can not be avoided by simply discarding one of the terms, even tho that be the most disreputable. Nay, there is need for all of these terms to distinguish quite definite branches with distinct purposes or interests. The ethnic is distinct from the cultural, and the cultural from the social, tho these three developments are inseparable, for the ethnic and the cultural both imply the social.

Is the social to be regarded as more comprehensive than the ethnic? Yes, for three reasons: the social extends into the biological and zoölogical fields; then the ethnic always implies the social as the fundamental element in the ethnic group, community, cult, custom, or institution; and finally the higher developments of the human mind and society in institutions, arts, and languages are regarded as social in a broader sense than that of ethnic relation or even of ethnic culture; and so the materials and data of the Social Sciences are hardly ever treated as ethnological.

The term *ethnology* is needed for the ethnic as distinct from the social and also from the anthropological, and as comprising not only the descriptive study of ethnic materials in ethnic groups,

whether racial or not, but also the comparative study of the data of the ethnic development of mankind. The term *ethnic anthropology,* by some proposed as equivalent,[7] had better be restricted to the comparative study of ethnic data for anthropological interests, that is, for a general knowledge of the ethnic traits of mankind; and the sister term, *culture anthropology,* should be more narrowly restricted to the study of man's culture in ethnic materials with especial regard to primitive culture and cultural development. Ethnology then would comprise both these studies as a more general, comparative, and explanatory science. Its descriptive counterpart is Ethnography, the detailed study of ethnic materials in ethnic groups, races, or peoples, which furnishes data from which both Ethnology and Ethnic Anthropology draw their conclusions.[8]

Ratzel, however, made Ethnography comprise both descriptive and explanatory studies. (*History of Mankind,* London, 1896–8). Brinton went to the other extreme in applying the name Ethnography to the older Ethnology of racial characters, origins, and relations. (Dieserud, *loc. cit.,* p. 37).

Anthropogeography, or Human Geography, the study of the distribution and the economic or ecological relations of mankind to geography, is on the one side, as comprising aspects of the adaptation and migration of ethnic groups or races, closely related to Racial Anthropology; but on the other side, as dealing with the historical, social, and cultural effects of geographic conditions and situations, it is no less relevant to Ethnology as broadly defined, and it is accordingly here subordinated to it and placed just after Ethnography and just ahead of Social-political History.

Ethnology and Ethnography deal for the most part with existent peoples, but also to some extent with historic peoples, especially in recent periods and in the present. Herein these two branches are the more closely ancillary to Sociology. The ethnography of an existent European or Asiatic race involves certain results of its recent history, and may even reach back into its past history. The descriptive science of traits and manners, institutions, customs, and cultures

[7] See Dieserud, *The Scope and Content of the Science of Anthropology,* pp. 14, 17, 40, and 63.

[8] Dieserud, *Op cit.,* pp. 29–49, citing and quoting many authorities.

merges into the historic account of origins and changes. Ethnic and Culture Anthropology, Ethnic Archeology (paleo-ethnology), Folk-lore, Ethnography, and Anthropogeography are ancillary to Social-political History and this in turn is auxiliary to them. So they may very properly be placed just ahead of that historical counterpart of the Social Sciences.

History, broadly considered, comprises not only the history of humanity, but also the sequential aspects of natural events and developments.

"History in the wider sense is all that has happened, not merely all the phenomena of human life, but those of the natural world as well. It includes everything that undergoes change; and as modern science has shown that there is nothing absolutely static, therefore the whole universe, and every part of it, has its history. . . . The universe is in motion in every particle of every part; rock and metal merely a transition stage between crystallization and dissolution. This idea of universal activity has in a sense made physics itself a branch of history. It is the same with the other sciences — especially the biological division, where the doctrine of evolution has induced an attitude of mind which is distinctly historical." [9]

The historical method is one of the three general expository modes of viewing the fields of knowledge, or of treating the data of knowledge, the other two being the analytic, or descriptive, and the synthetic, or philosophic. But in truth none of these modes is quite exclusive of the others. History, science, and philosophy are comprehensive of all the fields of knowledge. Every study has its historical aspect, or may be treated historically. History comprises all these special histories and also the histories of the sciences, philosophies, and literatures. In a system of classification, however, those special histories are consistently subsumed under the general classes, or captions, for those subjects; thus the history of art under Art, the history of astronomy under Astronomy, etc. What is usually called History and what we place here as a branch of the Social Sciences may more properly be termed

[9] Prof. J. T. Shotwell, in *Encyclopædia Britannica*, XI ed., v. 13, p. 527.

the History of Humanity and of Social-political and Ethnic Groups.

As ancillary to the history of humanity but more directly subordinate to Sociology, the ethnologic group of studies precedes Social-political History in our series. The terms *ancillary studies* and *auxiliary sciences* are usually assigned also to another group of more special studies classified as within the domain of History: Archeology, the study of ancient relics, especially those that embody art elements; Epigraphy, the study of inscriptions; Paleography, the study of olden writings, especially in manuscripts; Diplomatics, the study of documents and archives with regard to their authentication; Sphragistics, the study of seals as contributing to the authentication and dating of manuscripts; Numismatics, the study of coins; Chronology, the science of measuring time, of fixing dates, and assigning the succession of events; Heraldry, the study of arms and blazonry; Genealogy, the study of family successions; and Historical and Political Geography,[10] which is more descriptive than the related branches, Anthropogeography and Physical Geography. These studies all have scientific elements in them, mostly descriptive, but some theoretical. They are, however, on the whole less scientific than the descriptive and comparative sciences of the ethnologic group. In so far as these "auxiliary sciences" are entitled to bear the term *science*, they contribute scientific materials to History, which therefore develops a scientific method of its own, becoming in a degree scientific, tho it produces little generalization and its conclusions are seldom theoretical and rarely extend to prediction.

". . . history will develop a technical literature, the prerequisite of progress. In time this will react upon popular history, which will slowly become scientific in the sense that modern popular chemistry or zoölogy is scientific. . . .

[10] Jean Brunhes distinguishes Historical Geography from the Geography of History as well as from the History of Geography in his chapter on "Human Geography" in *The History and Prospects of the Social Sciences*, edited by Prof. H. E. Barnes.

". . . anthropology, sociology, perhaps above all of psychology. It is these sciences which have modified most fundamentally the content of history, . . . and supplied scientific canons for the study of mankind. They are the auxiliary sciences in a far deeper sense than are paleography, diplomatics, or even philology. The sciences relating to mankind will hereafter dominate the work of the historian. His task, it will be seen, is nothing less than the synthesis of the results of special sciences, a task so grand and comprehensive that it will speedily wean him altogether from literature. . . ." [11]

Tho History as a mode of treating facts is very comprehensive, Social-political and Sociological History, as branches of the Social Sciences, are much less general and comparative than Sociology and Ethnology and therefore succeed those sciences in our series; but as descriptive and explanatory they cover an equally wide range of human activities and attainments, including the political, the economic, the ethical, the artistic, and the philologic — the range of studies called *the humanities* in the broader sense of that term.

The relations of History to Social Psychology and to the more special findings of Racial Psychology should not be overlooked. That History is intrinsically a psychological science has been cogently urged by Karl Lamprecht; and in this regard ". . . . the main question has to do with social-psychic as compared and contrasted with individual psychic factors; or, to speak somewhat generally, the understanding on the one hand of conditions, on the other of heroes, as the motive powers in the course of history".[12]

History is thus not a mere narrative of events, of deeds and persons, of wars and happenings, but it is a coherent account of human, of social, of political, of moral, of intellectual, and of artistic developments and attainments, affording data for scientific knowledge and general views for philosophic thought.[13]

[11] James Harvey Robinson, *The Congress of Arts and Science,* v. 2, pp. 50–1.

[12] *The Congress of Arts and Science, Proceedings,* v. 2, p. 111.

[13] Important examples of such broad treatment are *The Cambridge Modern History* and *The History of Civilization,* a series of volumes of very broad

3. RELIGION, ETHICS, AND THEOLOGY.

Religion is one of the most comprehensive of the anthropologic developments. Subjective, personal religion is distinguished from objective, social religion, which combines mythological and theological beliefs with communal ritual, worship, and service. The science of religion belongs with the Anthropological Sciences, but abstract Theology is subsumed under Philosophy. Religion is closely related to Ethics, and Ethics to Sociology. This collocation seems essential. Morals as objective are the data of the social science of Ethics, which includes its related philosophy, and is normative or practical. The importance of ethical, ameliorative social science is emphasized.

As an anthropologic, mental, social, and ethnic development, religion compares with language and with art as being most deeply rooted in human nature and comprehensive of the whole range of human life. Religion reaches up thru the individual and social affections and attitudes regarding the powers and providences, beauties and splendors that pervade the environing world, and in a profound sense it comprehends the whole spiritual life of man. The spirits, which in primitive stages are imagined as animating natural objects and forces and as dominating the lives of men and beasts for good and for evil, are in later stages transcended in the conceptions of omnipotent and omnipresent God. In the presence of the immense, the incomprehensible, and the awe-inspiring, the human mind, contemplating the world, conceives and adores the Holy and Divine as pervasive or immanent. Whether this conception reflects reality is a question for philosophical theology.

There is subjective, personal religion, the spiritual relation, or consciousness, or attitude, of a human mind to God, as conceived by that mind; and there is religion objective and social, sustained in a community of minds.[14]

scope in course of publication under the general editorship of Henri Beer, the title of the French original being *L'Evolution de l'humanité*. In his general Introduction M. Beer emphasizes the relation of history to anthropology and even to biology. Other influential exponents of this broad treatment of history are James Harvey Robinson, H. G. Wells, in his *Outline of History*, and H. E. Barnes, in *The New History and the Social Studies*, and in *The History and the Prospects of the Social Sciences*, edited by him.

[14] "The religious sentiments, in distinction from those of a merely moral sort, seem to involve a definite sense of *personal relationship* to a supreme, or at least superior, being." — Angell, *Psychology*, 4th ed., p. 448.

Objectively a religion is a duplex development, a system of *beliefs,* a mystic web of concepts and meanings, and also, interwoven with this, a *cult* of worship and service, of morals and conduct.[15] In the one aspect theoretical, regarding the nature and relations of the superhuman being, or beings, that are conceived or believed to control nature and human life, in the other aspect religion is practical and normative, regarding the means of serving the divine, or propitiating the beneficent or malign powers. The beliefs develop into mythology and theology, the practices differentiate in magic, ritual, worship, and service. A religion thus becomes more than belief and worship; it becomes a service to a cult or church or community, or to the whole of humanity; it becomes a devotion to its ideals of life and to its rules of conduct.

"The new church, in short, will be primarily a clearing-house of service, to which men will go not to save their souls but to save their world. It will be a spiritual center, so to speak, of all service-activities. . . . The leader of such a church will be a man not only deeply interested in and in touch with the agencies and activities of human betterment, but versed likewise in the fundamental sciences that make for a finer direction and control of life. His theology will be not an occult research of supernatural relationships and powers, but physics and chemistry, biology and sociology, ethics and philosophy — all the fundamental approaches, in short, to the problem of human self-realization." [16]

Religion thus has a psychological background, an ethnical perspective, and an ethical foreground. As belief and service, as theoretic and ethic, it is at once personal and social, but the social predominates; and therefore the science of religion belongs to the anthropological and more especially to the social sciences.

On the scientific side this study is closely related to Ethnic Anthropology, to Folk-lore, and to the study of Morals.

[15] "Une *religion* est un fait social. . . .

"Or, avant qu'il y ait un culte et une tradition, il y a déjà une croyance, et par suite une religion.

"Nous définirons la religion *l'union dans une même croyance,* la *communion des fidèles.*" — Goblot, *Op. cit.,* pp. 224 and 228.

[16] Prof. H. A. Overstreet, *Forum,* Oct. 1914, v. 52, p. 507.

But, on the philosophic side, the philosophy of religion reaches into abstract Theology, Cosmology, and Metaphysics, while Ethics coalesces with the philosophy of human nature and human life.[17] To separate these scientific studies from the branches of philosophy is, however, more justifiable than would be the severance of such important relations as those between Religion and Social Ethics. Ethics is complementary to religion and still more positively social. The interests of religion are so intertwined with those of ethics that in a graded series and also in a practical classification the two branches should be contiguous and adjacent to Applied and Ameliorative Social Science, Philanthropy and Charity.

The science of religion is descriptive, historical, and comparative. The history of religion and the comparative study of religion are closely implicated branches.[18] "Comparative Religion is a branch of empirical science which aims at describing in formulæ of the highest generality attainable the historical tendencies of the human mind considered in its religious aspect. Its method will primarily be that of a Social Psychology; since it will work directly from the implied or explicit notion of a social subject, to which the tendencies it describes will be held to belong essentially." [19] To these comparative studies should be subordinated the studies of particular religions, including the Christian, the Hebrew, the Mohammedan, etc., and their special theologies, ethics, and ecclesiology.

Ethics comprises the science of morals and the philosophy of morality. Here science and philosophy merge and the

[17] "But these circumstances must not blind us to the fact that religion and a philosophical theory of the world, so long as the latter keeps to its own ground, are two different things. Religion is a definite state of feeling and will, basing itself on inner experience and on historical facts." — Harnack, *Congress of Arts and Science,* v. 2, p. 630.

The relation of Ethics to the sciences of human nature is emphasized by Robert C. Givler in his interesting chapter in *The History and Prospects of the Social Sciences,* edited by H. E. Barnes.

[18] "By far the greater number of investigations make their studies of comparative religion historical or evolutionary." — Dr. Gray in *International Encyclopedia,* article on Religion.

[19] Marett, *The Threshold of Religion,* p. 168.

tissue is so interwoven with religion that the studies are inseparable. As in our system the philosophy of mathematics belongs under Mathematics and the philosophy of æsthetics under the Fine Arts, so the philosophy of morality should be collocated with Ethics and the Science of Morals. Like the Science of Religion, the Science of Morals is descriptive, historical, and comparative.

Morals as objective are the data of the Science of Ethics, which describes the norms rather than prescribes the rules of ethical conduct. Yet there is a tendency to apply this science, to make it *normative* and *practical.*

"Most men wish not only to understand human action, but also to regulate it; and indeed almost all writers on man and society introduce at least incidentally practical suggestions and criticisms passed from a practical point of view. They apply the ideas 'good' and 'bad', 'right' and 'wrong', to the conduct or institutions which they describe; and thus pass, sometimes half unconsciously, from the point of view of Psychology or Sociology to the point of view of Ethics or Politics. It is true that the mutual implication of the two kinds of study is, on any theory, very close and complete." [20]

Morality, like religion, may be subjective or objective, personal as well as social. There are two opposing principles in life, self-maintenance and dependence on others. From this opposition morality arises, and it combines the two opposing principles as two aspects of one condition, involving sociality, mutual help, sexuality, parenthood, and love. That the social predominates in the moral and ethical even more than in the religious is sustained by many recognized authorities. The social of course is grounded in the anthropological and the psychological.

"Ethics is, according to the Greek signification of the term, a science of customs or morals (*Sitten*)." . . .

The theoretical science to which ethics bears this relation is the science of man, *anthropology* and *psychology*. Presupposing a

[20] Sidgwick, *Methods of Ethics*, London, 1877, p. 2.

knowledge of human nature and the conditions of human life, ethics undertakes to answer the question: What forms of social life and what modes of individual conduct are favorable or unfavorable to the perfection of human nature? [21]

"Whether or not notions of right and wrong begin to dawn in consciousnss before any social relations are established, their development is a result of association." [22]

"This social genesis of the idea of self lies at the root of morality, . . .

"For the essence of moral conduct is the performance of social duty, the duty prescribed by society, as opposed to the mere following of the promptings of egoistic impulses.". . .

"Moral conduct consists in the regulation and control of the immediate promptings of impulse in conformity with some prescribed rule of conduct." [23]

Humanity, having progressed thru the stages of mental, social, and economic development, now enters upon its present great era of higher organization and application of knowledge to the difficult problems of amelioration, socialization, and true civilization. Applied morality, coöperating with religious service, ministry, and missions in undertaking to redeem the world from the results of unethical and morbid conduct, from selfishness, sin, and vice, develops into the immensely important systems of ameliorative social work, combining philanthropy, organized charity, and social legislation. These movements and institutions are organizations of purpose that should be established upon an organized knowledge of social conditions, of inferior races, and of social pathology, of the scientific, economic, and political remedies, of criminology, penology, and social eugenics. All these studies are to be comprehended under the term Applied and Ameliorative Social Science. From this it is but a step to Political Science and Jurisprudence.

[21] Paulsen, *A System of Ethics,* New York, 1903, pp. 1 and 2.

[22] Giddings, *Principles of Sociology,* New York, 1898, p. 45.

[23] McDougall, *Social Psychology,* Boston, 1914, pp. 180, 313, and 314.

4. POLITICAL SCIENCE, JURISPRUDENCE, AND ECONOMICS.

Social communities pass from the stage of band to that of organization. Political relations are outlined as developing into political organizations. The branches of Political Science are summarized, including Jurisprudence and Law. Economics is defined and its branches named.

Social communities are not merely racial and linguistic groups but mentally and ethnically they are communities centered about certain ideal and traditional customs (mores). Some of these are merely mental and are subject to gradual, transmitted change; others, however, become established more permanently as institutions; and some are embodied in substantial forms, or systems, as statutes or codes and as bodies or organizations.

The three stages of tradition are exemplified in the history of puritanism in New England. At first merely a community, "a state of mind", a religion and a morality, puritanism soon established the New England family, school, and church as institutions resting more rigidly than elsewhere in America on established religion and morality; then it stabilized these institutions not merely in material structures, school-houses and meeting-houses, pillories and ducking-stools, court-houses and jails, but in statutes and codes, in social and religious organizations, and in organizations of interest and of purpose.

On traditions, customs, institutions, morals, and laws, a community depends for its coherence and permanence. It therefore protects them from disintegrating or demoralizing forces within and defends them against hostile forces without. For these purposes and in order to impose its collective will on its constituent members the group, or cult, or people, organizes and establishes its chief institution, its government. The relations between the government and the governed, the duties and obligations of the citizens, are defined and adjudicated by laws and courts, are regulated by administrative functions and are controlled by *sanctions* of public opinion and penal institutions. Hence the legislative, judiciary, administrative, police and penal branches of political organization. The relations of states, or of citizens, to foreign states, or citizens, are another field, and the duties, functions, and services of states to their citizens still another field of political organization.

These are the political relations, and in these the social community becomes a political body, or "body politic". The larger social-political communities are the nations, distinguished in their later development neither by race alone nor by language, but rather

by traditions, institutions, and persistent mental traits. The lesser social-political communities are the states, counties, provinces, etc., which are comprised within the nations or are dependent on them, — also the cities, towns, villages, etc. A nation organized under an established and recognized government is a *state* in the precise sense of the term, which is similarly applied to independent cities, as in ancient Greece and in medieval Italy.

The state is the nation organized; it is basic to the government, maintains the institutions, and sanctions the enforcement of laws and morals. Two attributes usually ascribed to states are autonomy and sovereignty, tho the former is often contingent and the latter is more or less questionable.[24]

Political Science is the systematic study of political relations and institutions, of civic duties and obligations, of constitutions and governments, of legislation and administration, of the state and the relations of states to other states, and of the functions and services of governments in protecting, conserving, and regulating public and private property and undertakings. The term *politics* was formerly used in a theoretical sense, but now is used mostly in the special sense of practical or party politics, too often bearing the sinister imputations of grasping for political power, privilege, or profit. Like the other sciences of this group, Political Science is descriptive, historical, and comparative. Its generalizations rest essentially on political history and sociology. It adduces principles and lays down basic facts applicable to *practical politics* in the broader sense. On the philosophical side political theory passes into Political Philosophy and this underlies the philosophic and normative study of Political Ethics, and the Philosophy of Law or Jurisprudence.

The branches of Political Science correspond broadly to the more distinctly important relations, interests, and studies denoted by the respective phrases in the foregoing paragraphs. They may be summarized very briefly. More theoretical are Political Philosophy and Theory of the State;

[24] Prof. F. H. Giddings in his interesting *Colver Lectures* on *The Responsible State* shows that the powers of the state are not absolute and its sovereignty is conditional. (See especially pp. 45–8). In the last chapter of this little book, he summarizes the "Duties of the State", tho concisely, much more adequately than in our brief sentences above.

more descriptive are Political Ethics, Comparative study of Governments and of Constitutions, and Civics (the relations and duties of citizens to states and the functions and services of states to their citizens). Jurisprudence is both theoretical and descriptive, and also normative. Normative and practical are the studies of Legislation, the Judiciary, Administration, Diplomacy, Practical Politics, and Law. The protective and regulative functions and services of states, or governments, comprise the Police, Military, Naval, Civil, and Consular, and the regulation of crime and punishment, industry, commerce, transportation, finance, money, insurance, natural resources, and social welfare.

The last interests interlock with Economics, resting on biologic, ethnographic, and geographic grounds. Economics is the science of human wants and goods and values, of the production, exchange, distribution, and consumption of goods. It is a social science, not political, so the older synonym *political economy,* now falling into disuse, was a misnomer applicable only to a portion of the field.[25] Social economics, tho nearly coextensive with Economics, is, however, a term of more special connotation; for wants and values may sometimes be merely private, biologic, or anthropologic, albeit usually with social implications.

Economics is a science of relations especially, of innumerable, intricate relations, — very difficult to classify. This science too is descriptive, historical, and comparative; and it also conducts to normative and practical conclusions. It may broadly be divided into (1) General and Theoretical Economics, (2) Special and Applied Economics, (3) State Economics and National Economies, and (4) Private Economy. Social Economics is subordinated to General and Theoretical Economics. Of Special and Applied Economics the chief branches are Special Social Economics, Industrial Economics, Exchange (comprising Commerce, Business, and

[25] Originally in Greek usage the term *economics* denoted the prudent study and systematic management of household economies. Thence the term *political economy* extended this meaning to the management of the financial affairs of the state. To this study as virtually a part of political science he term *state economics,* or *political economics,* would be properly applicable. The science of Economics has developed much more broadly and the term *political economy* no longer fits it.

Finance), Transportation, and State Economic Services, Public Utilities, etc. Business should be distinguished both from Industry and from Commerce as the relatively private handling of the profitable results of production and exchange. State Economics, defined as the study of the economic functions, relations, and services of the State, is descriptive, comparative, and theoretical, but becomes concrete in the several national economies.

5. INDUSTRIES, TECHNOLOGIES, AND ARTS.

The arts in their various methods apply knowledge of many kinds. The relations of the industrial arts and technologies to applied natural sciences and to industrial economics are indicated. In Agriculture and Engineering many sciences and arts are applied. A residual class is termed Useful Arts, and in this several sub-classes are distinguished. The Fine Arts are specially characterized. Music is the most spiritual art. Poetry and Drama are the most expressive. Language is an elemental, literature a consummate art; so Philology is placed after the Arts, as the last of the Humanities. Literature returns to Philosophy, completing the circle of studies.

From the economics of industry, treating of relations, principles, and laws, it is but a step to the industrial arts, and especially to the productive arts, which apply both economic and scientific knowledge. The technical arts may be highly scientific. This applies especially to manufactures involving physical actions or chemical processes; but it applies also to mechanic arts and handicrafts.

An *Art* is a method of doing or making or producing some thing that does not exist as such in nature. It is implied here that the requisite abilities and dexterities are not merely natural, but are acquired partly thru training, and are more or less dependent on special knowledge applied to the purpose.

Technology is the systematic study of the application of scientific knowledge, especially physical, mechanical, and chemical, to constructive, fabricative, and productive art. Some technology is so scientific that it is inseparable from the science on which it is chiefly dependent, for instance, electrical, and acoustical, and optical. Where many technologies applying several sciences are studied together the term *polytechnics* is appropriate.

Engineering, in all its diverse branches, is predominantly technical and scientific, but the practical studies are not all so closely involved with the theoretic as in the instances given above. To classify all technical studies under the several sciences would overload these with material that is largely of extraneous interest. Agriculture is not merely applied botany but contains chemical, geological, and economic knowledge and applies business ability, common sense, and philosophy of life. Structural, Mining, and Military Engineering do indeed apply mechanics, chemistry, and geology, but they do not belong in those sciences and they are less inconvenienced by separation from them than those sciences would be inconvenienced by having them in their midst.

Some technologies and arts that depend less on scientific knowledge may conveniently be classified in a residual class termed Useful Arts, or Industrial Arts, which may conveniently have several divisions, for instance, Mechanic Arts, Manufactures, Handicrafts, Domestic Arts, etc.

From the Useful Arts it is customary to distinguish the Fine Arts, in which utility is less regarded than beauty, or some kindred æsthetic quality. The fine arts deal with perceptual [26] objects and perceptual media of expression, but also with conceptual meanings, ideals, symbols, and imaginative elements, and especially with human interests, affections, and emotions. That they are pleasurable, cultural, educative, and edifying are among their most important values. They afford pleasure of the most refined nature, arising from refinements of sense, perception, imagination, and expression.

Æsthetics, the philosophy and criticism of the fine arts, should be the first subject under this caption. As the main division, the *tectonic* arts, including Architecture, Ceramics, and other constructive arts combining æsthetic with utilitarian qualities, may be distinguished from the *Representative, Imitative,* or *Expressive* Arts, which represent, or ex-

[26] *Æsthetic* is a term derived from the Greek αισθάνεσθαι, meaning to perceive by the senses, but much more is now connoted by the term.

press, the things of nature and of life, whether realistically or symbolically, with some intellectual, emotional, or æsthetic quality and with little regard for mere utility in a physical or economic sense. But a plainer distinction is customary between the *Plastic* Arts (including Sculpture and Ceramics and certain minor arts) and the *Graphic* Arts, which represent objects by lines and perspective, lights and shades, colors and impressional effects on a surface, including the pictorial and decorative arts, Drawing and Design, Painting and Mosaic, Engraving and certain related minor arts. The Decorative and Textile Arts combine graphic and fabricative qualities. It is evident that the classification of the arts is no simple matter. Their very freedom permits them to interchange methods or mediums of expression or subjects for representation.

There is a group of arts the especial purpose of which is to give pleasure, but in which the purely æsthetic element is less patent. The Arts of Pleasure, as they are sometimes called, tho more consistently the Recreative Arts, are indeed arts of pleasurable activity, requiring some skill, and they may be regarded as including Pastimes and Amusements. Dancing may have more of æsthetic expression, chess more of mental grasp and mastery, golf and billiards more of physical skill and recreation, and bowling and boating more of bodily exercise and social pleasure.

The term *Expressive* Arts is applied especially to Music and to Poetry and Drama, and more broadly also to all language and literature. Language indeed is more than art; as expression and communication language is basic and elemental, and it is serviceable in a very high sense in many relations of human life but especially in the intellectual interests. The word, or the sound, has its mental or conceptual correlate. In music this mental correlate is vague, tho still *expressional.* In painting, sculpture, and architecture, and especially in their symbolical elements, the meanings are hardly less vague and are merely *impressional* or *suggestive.* In

language and literature, however, the expression is comparatively definite and precise. Music produces feelings and emotions which give rise to ideas or meanings, tho these are neither explicit nor coherent. But language makes ideas explicit and thoughts coherent; and highly poetic and dramatic language stirs emotions not less sublimely than music, tho it may be less delightfully, for music excels all other arts in sensuous charm. Music is thus esteemed the transcendent art, the most spiritual and etherial. On the one hand music is compared with architecture, as "architectonic"; on the other hand it is compared with the plastic mediums of clay and pigment and the woven textiles. Not only does music embody ideas, tho so supersensuously, but it moulds these into forms that become significant; and about these it weaves its delightful fabrics of sound, inspiring emotional thoughts in its marvelous, ineffable language.

Philology is the comprehensive name for the study of language and literature, the word and the fabric of words. Thus it is divided into three branches: Linguistics, the study of language; Literature, the study of written language as more or less artistic expression; and the arts of Oral Language, of speech, conversation, artistic reading, oratory, and elocution, including dramatic elocution and even the more composite study of dramatics. Rhetoric more broadly is the study of the art of expression in language. Language is an art; linguistics is the partly scientific study of language; literature may be regarded now as a body of writings, now as a subject of study, historical, critical, and æsthetic. Poetry, drama, dramatics, elocution, and oratory are fine arts. Speech conversation, literature, and journalism are appreciably arts, or artistic bodies of expression and communication in language. The many languages are classified on grounds that are more or less scientific. The classification of the Fine Arts and the subjects of Language and Literature presents many difficulties, which we will subsequently deal with more definitely.

Poetry and Drama are indeed with reason classed under the Fine Arts; they are the most complete and adequate art expression, not lacking in suggestive and mystical meanings and emotional expressions. It is hardly possible, however, to define poetry and drama as positively distinct from kindred expressions in *prose* literature; and plainly literature is not all artistic — neither in purpose nor in manner. Yet in the broader sense of the term art, language is elemental, literature consummate art. Hence we are led to place Language and Literature, or Philology, at the end, as the last of the *humanities,* and of our series of fundamental studies. In the one aspect this terminal caption is no less comprehensive than the first, Philosophy. Literature too comprises all fields of knowledge and thought. In another sense we may say that the encyclopedia of studies is complete and the circle returns unto itself. Literature is thought arising from knowledge and at its best expresses good philosophy. Philosophy is thought well grounded in knowledge and at its best is moreover good literature.

6. RECAPITULATION AND TABLE.

Main divisions, fundamental sciences, and derivative studies have been defined and outlined within the synthetic unity of knowledge. There is gradation by speciality, and serial dependence. The series is recapitulated. This order is more adaptable than arbitrary systems are, and it is consistent with the scientific and pedagogic orders. As a fundamental structure, it affords maximal efficiency in a functional organization of knowledge.

We have surveyed the system of the sciences and arts synthetically, with some definitions and with indication of the most important relations. The main divisions, the fundamental sciences, and the derivative groups of studies have been outlined or defined; and the correlative branches of philosophy have been mentioned. The entire system of knowledge has been regarded as a unity grounded in the unitary order of nature and has been consistently adapted to the logical and educational orders, which are not only correlative to the order of nature but are conditioned by the unity

of the individual mind and the community of the social mind, and by the scientific and educational consensus. On this structural basis the systemization and functional organization of knowledge may most effectually develop and progress for the advancement of research and the amelioration of the social-economic conditions of human life.

Those main divisions imply logical or conceptual distinctions but not real or actual separations. "With the attainment of perfect knowledge, these lines would disappear, the more specialized sciences being absorbed in the less specialized by reduction of the more complex processes to the more elementary, and by exhibiting the elementary in their complex combinations." [27]

There are no unbridgeable gaps between the fundamental sciences, even tho there be unsolved problems and regions of reality to which our science has no present means of access. Intelligence accepts the truth that in all probability there is some real transition from sphere to sphere, from the physical to the vital and from the vital to the mental, as there plainly is from the natural to the human and from the individual to the social, and as we may rationally believe there is from the human to the divine and the universal. [28]

Herein gradation is implied. Logical definition and scientific analysis proceed from the more general to the more and more special. *Gradation by speciality* we have termed the main principle of our classification.

Interrelated in manifold ways tho the sciences and their derivative studies are shown to be, there is a principle of serial *dependence* that is three-fold in its complexity, logical, developmental (or historical), and pedagogical. Each of the fundamental sciences is thus dependent on those that precede

[27] Stout, *Analytical Psychology*, vol. 1, p. 6.

[28] A recent philosophic essay more largely developing somewhat similar ideas is Lloyd Morgan's *Emergent Evolution. Gifford Lectures for 1922.* "Through emergence there is progress in continuity." (p. 5) "Each higher entity in the ascending series is an emergent 'complex' of many entities of lower grades, within which a new kind of relatedness gives integral unity." (p. 11)

it in the series, and especially dependent on that which comes next before it. The derivative and applied sciences, subsciences, technologies and arts partake of that serial dependence, tho complicated with subordinated serial orders and interrelations of particular dependence. As the correlation between the logical and the pedagogical order is closely coherent, we may consistently affirm that the orders are *established in the scientific and educational consensus.*

Moreover in this orderly system there inheres a *maximal convenience* or *efficiency* by reason of the collocation of the greatest number of most closely related subjects of study and thought.

A brief recapitulation will serve to introduce the table that follows. The branches of philosophy in the first column parallel the fundamental sciences and their main derivatives in the second column, interconnected with the respective historical studies in the third column, and with the applied and concrete sciences, technologies and arts in the fourth column. The most general and abstract studies under Philosophy are Ontology, Cosmology, Theology, and Epistemology; and under the Abstract Sciences and General Methods are Logic, Mathematics, and Statistics. The Natural Sciences are divided from the Anthropological Sciences, tho not separated from them, for Anthropology is linked with Zoölogy and with Biology. The former series comprises the Physical and the Biological, the latter series comprises the Psychological and the Social. Under the Physical are Physics, Chemistry, Astronomy, Geology, and Geography. The Biological Sciences include not only the more general morphological and physiological studies but the more and more special studies of Botany and Zoölogy. The Anthropological Sciences comprise Physical Anthropology, Psychology, Sociology, Ethnology, Folk-lore, Religion, Ethics, Political Science, Jurisprudence, and Economics. To the last are closely related the Industries and Arts, and from these it is a logical step to Philology and the studies of the languages and literatures.

SYNOPTIC TABLE

OF THE

CLASSIFICATION OF KNOWLEDGE

PHILOSOPHY.	SCIENCE.	HISTORY.	APPLIED SCIENCES.
Principles. Ontology (Reality). Epistemology.			
	Philosophy of Science. Principles of Science.	History of Science.	
	Abstract Sciences and General Methods.		
	Science of Order.		
	Methodology.		
	Logic.		
	Mathematics.		
	Other general methods: Metrology, Statistics.		Applied Metrology, Statistics, etc.
Philosophy of Nature. Cosmology.	*Natural Sciences, General.*	Natural History. Evolution.	
	Physical Sciences.		Technology.
	Physics.		
	Mechanics, Dynamics.		Applied Mechanics.
	Matter, Energy, and Radiation.		
	Special Physics.		Physical Technology.
	Chemistry.		
	Physical and theoretical.		
	Mineralogy. Crystallography.		Petrography.
	Analytical and Special Chemistry.		Chemical Technology. Metallurgy.
	Special Natural Sciences and Descriptive Natural History.		
	Astronomy.		
	Theoretical, Mechanical. Astrophysics.		Practical Astronomy.
	Geology.		
	Physical and theoretical.	Historical and Stratigraphical.	
	Geography, Physiography. Meteorology.		Economic Geology. Economic Geography.
	Biological Sciences.		
Philosophy of Life.	Biology.		
	Cytology, Ontogeny, and Embryology.		
	Physiology and Ecology. Morphology.		Bio-geography.
	Genetics. Phylogeny, Organic Evolution.	Paleontology.	Eugenics.
	Botany.		Economic Botany.
	Zoölogy.		Economic Zoölogy.

SYNOPTIC TABLE (*Continued*)

PHILOSOPHY.	SCIENCE.	HISTORY.	APPLIED SCIENCES.
	Anthropological Sciences		
Philosophy of Human Life.	Anthropology.	History of Mankind.	Hygiene.
	Psychological Sciences.		Medical Science.
	Psychology.		Applied Psychology.
	General and Comparative.		Psychiatry.
	Individual.		
	Anthropological and Racial.		
	Social.		Education.
	Social Sciences.		Applied Social Science.
	Sociology.	Social-political History.	
	Ethnology.	Ethnography	
	Folk-lore.	Archeology.	
Philosophy of Religion.	Religion.	History of Religions, Churches, Cults, etc.	Church-work, Missions, Ministry, etc.
	Mythology.		
Theology.			
Ethics.	Ethics (science of morals).		Applied Ethics, Philanthropy.
Political Philosophy.	Political Science.		Government and Administration, Practical Politics.
Philosophy of Law.	Jurisprudence.		
	Comparative Law.		Law, Practice, etc.
	Economics.	Economic History.	Industrial Economics, Commerce, Finance, Business, etc.
			Private Economy.
Æsthetics, Philosophy of Art.		History of Arts.	Technology of Arts.
			Technic of Fine Arts.
	Philology.		
	Linguistics.	History of Languages, and of Literatures.	Grammar, Rhetoric, Oratory, and Criticism.
			Dramatics.

Astronomy is the most general of the sciences that deal mainly with concrete bodies, or classes of bodies, and is composite of mathematical, physical, and chemical science. Geology is concrete in that it is confined to the study of our planet. From Physical Geology, and more especially from Physiography and Meterology we pass to terrestrial Natural History and then to the biological studies and the more and more special studies of plants and of animals. Finally we attain to a scientific as well as historical and philosophical study of mankind and of the works of humanity, mental, social, and artistic. Ethnic Anthropology and Ethnology are closely related to Sociology, Ethics, and Economics. Of the special ethnic-social studies the most general are Religion and Ethics. Closely related to these are Applied and Ethical Social Science, including Philanthropy and Charity and Political Science and Economics, all of which are intricately interwoven. Economic production and exchange depend on the productive industrial arts and the mechanic arts, and those studies should be collocated. The arts in which utility is a secondary consideration to beauty and pleasure are distinguished as the Fine Arts, or Æsthetic Arts. First of these, Architecture links with Building, the last of the series of the Useful Arts. The most purely æsthetic is Music. Explicit expression is developed in language and literature. All the arts, languages, and literatures are mental and social products and so they are anthropological and ethnical developments. With literature the encyclopedia of studies is complete and returns unto itself in Philosophy, which enhances the truths of literature as literature humanizes the thoughts of philosophy and the verities of science.

Thus we attain to a clearer view of the unity and continuity of knowledge grounded in the unity and continuity of nature. The sciences and studies may be distinguished by their central interests, and they may be arranged in order of their speciality. As so arranged, they form an adaptable structure for a more efficient functional organization of knowledge.

PART IV

A HISTORICAL SURVEY OF SYSTEMS OF KNOWLEDGE.

Now, when all these studies reach the point of intercommunication and connection with one another, and come to be considered in their mutual affinities, then, I think, but not till then, will the pursuit of them have a value for our objects; otherwise they are useless.

. . . . . .

After that time those who are selected from the class of twenty years old will be promoted to higher honor, and the sciences which they learned without any order in their early education will now be brought together, and they will be able to see the correlation of them to one another and to true being.

PLATO, *The Republic,* Book VII, Jowett's translation.

CHAPTER XVI

FROM PLATO AND ARISTOTLE TO BACON AND HOBBES.

Classification, the tool of science, was long the toy of philosophy. The logical or metaphysical systems of the olden philosophers, lovers of knowledge with some of love's blindness, may have embraced entrancing aspects of truth, but they did not truly embody the order of nature, which indeed had not yet appreciably been discovered by science. They contributed little toward reducing the mental chaos of increasing complexity to an orderly cosmos of coherent relations and related conceptions.

It is not the present purpose to offer a history of classifications of knowledge, for that has been fairly well done by others.[1] What this chapter proposes is merely a concise survey of the chief historic systems as developing certain tendencies toward a scientific order, and as manifesting certain principles that enter into this book's argument. But it is only in the later stages of that progress that the scientific outcome is sufficiently clear; and so to these most space will be given. The earlier stages will be treated very briefly.

[1] Robert Flint, well known as the author of an estimable work on *The Philosophy of History in France and Germany,* has given us the most notable history in this field, in his book entitled *Philosophy as Scientia Scientiarum and a History of Classifications of the Sciences,* published by Blackwood in 1904. The preliminary essay of this work we have had occasion to cite several times before in preceding chapters. Our critical estimates of this and of other authorities may furthermore be consulted in "The Bibliographical Notes" at the end of the volume.

1. THE GREEK TRIAD.

From indistinct origins in the philosophy of Plato and Aristotle arose the triad of the Stoics: Logic, Physics, and Ethics. This, combined with the order of Aristotle, has persisted thru the ages and has developed into a true basis for the classification of knowledge.

To PLATO the triadic division of philosophy into Physics, Ethics, and Dialectics (or Logic) was ascribed by certain subsequent Grecian philosophers; and this ascription has been accepted by some leading historians of philosophy; but it was denied by Flint.[2] In *The Republic,* Book VII, Plato did discourse on certain studies, or "sciences", as distinct, especially from the pedagogic point of view. In Book III he had discussed the value of studying *music* first and then *gymnastic.* Here he considered in order the pedagogic values of arithmetic, geometry, astronomy, and harmonics. In this last he had, it is fair to say, some intimations of physics.[3] Tho he was intent on showing that this is the order in which these studies should be pursued, it is hardly right to ascribe to him the purpose to divide or classify the branches of knowledge.

Some studies he alludes to as *arts,* and he distinguishes these from *sciences.*[4] The dependence of the applied on the theoretical, however, he affirmed; and that there are stages of knowledge, — ". . . four divisions, two for intellect and two for opinion; and to call the first science, the second understanding, the third belief, and the fourth knowledge of shadows: . . ."[5] The visible world, the world of things, our knowledge of which he compared with their shadows, he contrasted with the world of ideas, "the intellectual world".[6] Of the things so shadowed we have beliefs or opinions. In the realm of ideas there are "conceptions", or imperfect "understandings", and principles absolute or universal, attained thru pure reason or intelligence. On conceptions, or "hypotheses", are grounded the sciences. "Custom terms them sciences, but they ought to have some other name, implying greater clearness than

[2] *Op. cit.,* pp. 69–71.

[3] To Jowett's translation of *The Dialogues,* in four volumes, New York, 1871, the citations and quotations given here refer, in this instance, to v. 2, p. 359.

[4] *Op cit.,* pp. 349 and 360–1. But geometry he calls a science on page 354 and on page 361 a "mathematical art".

[5] *Loc. cit.,* p. 361.

[6] *Loc. cit.,* pp. 341, 344, and 360.

opinion and less clearness than science; . . . ." But the highest science, which he called *dialectics,* seeks "the discovery of the absolute by the light of reason only, . . ." and "by pure intelligence . . . attains pure good, ..." [7] Here there is indeed some ground for the triadic distinction of natural science from ethics and from dialectics. But the interrelation of all the sciences, arts, and branches of philosophy he adumbrated just before [8] in the remarkable sentence quoted on the page facing the front of this chapter.

ARISTOTLE's tripartite division of knowledge differed both in scope and in terminology. Knowledge not only enters into science and thought but is applied to the conduct of life and to the arts. Hence the three divisions, Theoretical, Practical, and Productive. Theoretical Philosophy he subdivided into Physics, Mathematics, and Metaphysics.

"There is a science of nature, and evidently it must be different both from practical and from productive science. For in the case of productive science the principle of production is in the producer and not in the product, and is either an art or some other potency. And similarly in practical science the movement is not in the thing done, but rather in the doers. But the science of the natural philosopher deals with the things that have in themselves a principle of movement. It is clear from these facts, then, that natural science must be neither practical nor productive, but theoretical (for it must fall into one of these classes)." [9]

Metaphysics was not Aristotle's term but was assigned by his editors to what he called *First science,* or *First philosophy,* or sometimes *Theology.* "There must, then, be three theoretical philosophies; mathematics, physics, and what we may call theology, since it is obvious that, if the divine is present anywhere, it is present in things of this sort. And the highest science must deal with the highest genus, so that the theoretical sciences are superior to the other sciences, and this to the other theoretical sciences. . . . And it will belong to this to consider being *qua* being — both what it is and the attributes which belong to it *qua* being." [10]

Practical Philosophy comprised Ethics and Politics, and Economics, as auxiliary to Politics, to which Rhetoric also was treated as auxiliary because oratory was important to it. The term *Practical,* from the Greek πράσσειν, to do, to effect, implies effect on human actions or conduct. This meaning has persisted in the term

[7] *Loc. cit.,* pp. 360–1.
[8] *Loc. cit.,* p. 359.
[9] *Metaphysica,* Book XI, Chapter VII, § 1064 a, in v. 8 of *The Works,* tr. under Smith and Ross, editors, Oxford, 1908.
[10] *Op. cit.,* Book VI, Chapter I, § 1026 a.

Praktisch of Kant and other German philosophers. Productive Philosophy comprised Poetics and the Arts. In his treatise *On Poetics,* of which a fragment on epic poetry and the tragic drama is all that has come down thru the ages, Aristotle purposed to give a theory of the arts. The Greek name is from ποιεῖν, which has two general meanings, *to make* and *to do,* implying the arts as well as other things, but sometimes especially the arts. The first meaning is comparable with that of τεκεῖν, *to produce,* and τέχνη, *an art,* from which is derived our term *technology.* The second meaning is comparable and nearly synonymous with πράσσειν, *to do,* from which *practical* is derived. Thus we may see that these distinctions proposed by Aristotle prove difficult to maintain.

Logic, by Aristotle called *Analytics,* Wundt says he included in Theoretical Philosophy, and Flint says: "He regarded it not as part of philosophy, but as an introduction to philosophy, and especially to 'first philosophy'." [11]

There is an important truth in the broad distinction between the objective sciences of nature on the one hand and on the other hand the studies of arts and products and of human actions and conduct. This distinction survives in the traditional division of academic studies into the natural sciences and the mental sciences, or the humanities. But the successors of Aristotle found that the distinction between Practical Philosophy and Productive Arts was difficult to maintain, so they merged the two fields under the term *Practical.* It is hardly less difficult, however, to effect a *division* between Practical and Theoretical, for the theoretical serves the practical, while the practical becomes more scientific in technical study. We must conclude therefore that, however greatly Aristotle laid the foundations of many sciences, he failed to establish a true basis for the classification of the sciences. Yet the *order* that he indicated: Logic, Metaphysics, Mathematics, Physics, Ethics, Politics, Economics, Arts, tho incomplete, is, if his basic *divisions* be disregarded, consistent with the order of modern science.

From such indistinct origins arose among the Stoic philosophers of Greece the triadic division into Logic, Physics,

[11] *Op. cit.,* p. 80. Compare with Wundt, *Ueber die Eintheilung der Wissenschaften,* in *Philosophische Studien,* Band 5, p. 3.

and Ethics, which persisted thruout Grecian and medieval philosophy — "a Logic to guide the reason, a Physics to explain the world, and an Ethics to rule the moral life." [12] These three terms were used broadly, tho not so as to comprise all sciences developed since. In place of Logic the term *dialectics* often appeared; instead of Physics the broader Aristotelian term Theoretical Philosophy was usually preferred; and in lieu of Ethics, the more comprehensive term Practical Philosophy. The Stoics did not always agree as to the order of the three divisions, and their successors modified the sequence variously. Philo placed Ethics first; Plutarch placed Logic last. The division, however, persisted thru the ages, tho more or less perversely overlaid with dogmas and obscured with erratic absurdities. When combined with the Aristotelian order and supplemented with the humanities, with the expansion of Ethics, and the arts and technologies, it becomes the true basis for a classification of knowledge.

2. TRIVIUM ET QUADRIVIUM.

The "seven liberal arts" of the middle ages were divided into the *trivium* and the *quadrivium*, three studies more or less logical and four more or less physical and mathematical. These were preparatory to Theology (the principal study), to Metaphysics, and to Ethics, or Practical Philosophy. History was added by Vincent of Beauvais.

During the middle ages the seven liberal arts, — grammar, dialectics (or logic), rhetoric, geometry, arithmetic, astronomy, and music (including poetry) were in the curriculum of the scholastics the "disciplines" preparatory to the higher studies of theology, metaphysics, and ethics. In the fifth century MARTIANUS CAPELLA wrote an encyclopedic phantasia, usually known as *De nuptiis Philologiæ et Mercurii,* but also as *Satyra,* or *Satyricon,* the first two books of which are an "allegory ending with the apotheosis of Philologia and the celebration of her marriage in the milky way, where Apollo presents to her the seven liberal arts, who, in the

[12] Flint, *Op. cit.,* p. 86.

succeeding seven books, describe their respective branches of knowledge, ..." and who as her attendants or bridesmaids therein display their charms. [13]

Cassiodorus in the next century in his *De Artibus et disciplinis liberalium litterarum* designated the first three of these studies as *Artes* or *Scientiæ sermocinales* and the last four as *Disciplinæ* or *Scientiæ reales.*

These two groups of studies were thruout the middle ages termed *trivium* and *quadrivium,* the former treating of *words,* propositions and expressions, and the latter treating of *things* and supplanting the Physics of the Stoic triad. Ethics was by the scholastics subordinated to theology, which as the highest study dominated medieval thought.

Isidore of Seville at the beginning of the seventh century in an encyclopedic work that "for many centuries was a much valued authority" added to the seven liberal arts and sciences several others: Medicine, Law, Chronology, Theology and Ecclesiology, Cosmology, Geography, besides other studies of language, of society, of man, of animals, and of various arts and technologies.[14] All this, however, was not quite encyclopedic and not very systematic.

Hugo of St. Victor in the twelfth century, like scholars of that age following Aristotle as authority, adapted his Theoretical Sciences to the medieval mind by placing Theology (which Aristotle had subordinated to Metaphysics) in the position of honor at the head. Mathematics he placed next, and then Physics; after this he put the Practical Sciences (like Aristotle including Ethics, Politics, and Economics); and these he supplemented with a group of seven Technical, or Mechanical, Arts: weaving, smith-work, navigation, agriculture, hunting, medicine, and the histrionic art. The trivium was there reduced to logic in a tail-end position.[15] This scheme shows, however, a considerable advance on Aristotle's

[13] *Encyclopædia Britannica,* article "Encyclopædia"; also Flint, *Op. cit.,* p. 89.

[14] *Encyclop. Britan., loc. cit.*

[15] Richardson, *Classification,* 2nd ed., p. 57.

basis; but to approach modern science it would have to change the positions of its head and its tail.

The famous scholastics, Albertus Magnus, Duns Scotus, and Thomas Aquinas, likewise adapted Aristotle's order by placing magnified Theology at the head and regarding it as comprising virtually the whole of Theoretical Philosophy, ethics also being included as closely related to theology. The quadrivium followed, and the trivium came last.[16]

In the thirteenth century two illustrious authors devised systems that will serve to exemplify the metaphysical and mystical types. St. Bonaventura, the "seraphic doctor" purported to show that all knowledge is derived from God. There are, he taught, four degrees of illumination, the *artificial,* by external light, the *natural,* by inferior light thru the senses, the *intellectual,* by the internal light, in which the mind reasons and conceives, and the *revealed,* by the superior light of the Divine Grace. The intellectual knowledge is tripartite, *natural, rational,* and *moral;* in the natural he comprised physics, mathematics, and metaphysics; in the rational he comprehended the *trivium,* and in the moral he included ethics, economics, and politics. This classification more completely than heretofore combined the Stoic triad with the trivium and quadrivium, so, despite its theological and metaphysical implications, it has considerable interest from our point of view.

Dante set forth a conception fantastic with astronomical analogy and mystical with symbolical meaning. Heaven, he fancied, is science, and, as there are ten heavens, so there are ten sciences. Perhaps this was the inception of the decimal fetish in classification. Cassidorus had, however, named ten sciences, and Varro nine. Dante's three inside planets, the Moon, Mercury, and Venus, were the trivium; the four outer planets, the Sun, Mars, Jupiter, and Saturn, were the quadrivium; and "mysterious analogies — so the poet, with

[16] *Cf.* Shields, *Philosophia Ultima,* v. 2, p. 58, and Richardson, *Op. cit.,* p. 57.

an imaginative subtility impossible to describe, seeks to prove — exist between each planet and the science of which it is the symbol, — between the Moon and grammar, Mercury and dialectics, Venus and rhetoric, and Sun and arithmetic, Mars and music, Jupiter and geometry, Saturn and astronomy." Above these are three superior heavens, the *stellar,* representing physics and metaphysics, the *crystalline,* for moral philosophy, and the eternal *empyrean* of theology.[17]

Vincent of Beauvais was the author of "the most famous encyclopedia of the middle ages, ... the great compendium of mid-13th century knowledge." This is of especial interest to librarians because of its title, *Bibliotheca mundi.* It might be said to have been the first "library" that, even without a building to glorify it, was a world in itself. To philosophers it is interesting as presenting the four views that in our chapter on Science we termed naturalistic, humanistic, pedagogic, and historical. Accordingly called *Speculum quadruplex,* its four parts were *Speculum naturale, Speculum doctrinale, Speculum morale* (ascribed to a later hand), and *Speculum historiale.* Here history was for the first time brought forward prominently in the circle of studies. Vincent's thirty-one books of it comprised a history of the world from the creation to the end of the world in A.D. 2376, "and the Last Judgment, and the renewal of all things".[18]

3. PRECURSORS OF SCIENCE.

Reisch in his circle of studies, including the seven liberal arts, the natural sciences and psychology, was the first to approach the order of modern science. Poliziano outlined a tree of knowledge. Nizolio combined the Greek triad and the Aristotelian division, but discarded Metaphysics and Dialectics. Bacon's divisions were arbitrary, erratic, and impractical. Campanella embodied correct ideas of science and history. Hobbes more distinctly approached the order of modern science. Comenius foreshadowed the pedagogic order.

In a small popular encyclopedia, *Margarita philosophica,* by Gregor Reisch,[19] published about 1496, there appeared an

[17] Flint, *Op. cit.,* pp. 96–7; Shields, *loc. cit.,* p. 57.

[18] *International Encyclopedia,* article "Encyclopedia".

[19] The forename is given as Gregor in *Allgemeine Deutsche Biographie,* as also by Shields and by Richardson. In *Encyclopædia Britannica,* how-

important modification of the scholastic order, an intimation of psychology in its broad scope. The first seven books of the work treated of the seven liberal arts and sciences (trivium and quadrivium); books 8 and 9 discuss the origins and production of all things (ontology, cosmology, and physics, thus involving theology and metaphysics); books 10 and 11 discourse on the soul (anima) "vegatative, sensitive, and rational" (psychology); and book 12 deals with moral philosophy. This was indeed an approach to the modern scientific order. Humboldt regarded it as the first encyclopedia to which may be traced the modern classifications of knowledge.[20]

The *Panepistemon* of Angelo Poliziano, or Politianus, renowned as poet and classicist, antedated the above (1491) in introducing psychology, and is of further interest to us as adopting the figure of the tree of knowledge rather than the circle of studies. Poliziano's tree divided into three main branches, revelation, discovery, and divination. It is the second of these that interests us, its three branches being *Spectativa,* or theoretical (comprising mathematics, physics, psychology, and *ontology,* with natural theology), *Actualis,* or practical (embracing ethics, economics, and politics), and *Rationalis,* or rational, including grammar, history, dialectics, rhetoric, and poetics. This combines the Aristotelian and Stoic triads with the scholastic schemes adding history; but it anticipated the modern tree of knowledge less than Reisch with his circle.

A more radical departure was taken by Mario Nizolio a half century later (1553) in the famous work called *Anti-barbarus,* in which he discoursed against the scholastics as pseudo-philosophers and barbarians distorting the Greek tradition. He discredited metaphysics and dialectics, giving them no place on his tree of knowledge (for he too used this figure), which he divided into Philosophy and Oratory, the latter dealing with language and its products (or arts), grammar, rhetoric, poetics, and history. Philosophy he regarded somewhat in the positivist view, anticipating

ever, the name appears as Georg, and in Larousse, *Dictionnaire Universelle,* it is Georges. A pamphlet in the New York Public Library is made up of eight bibliographical citations in detail, the first being that of Freiburg, 1503, and of this that library has a copy, in which the decorated title-page exhibits an interesting encyclopedic circle of the studies. *Britannica* and Richardson, however, give the date of original publication as 1496 and the place Heidelberg, and the *Deutsche Biographie* states that the work was published about that date. In the German citations mentioned above the name Gregor, or Gregorius, appears, but not Georg. Flint omitted even to mention Reisch.

[20] Shields, *Op. cit.,* p. 58.

Comte; and he divided it into Natural (physics) and Civil (politics, including ethics, economics, and jurisprudence). In Natural Philosophy he included geography, meteorology, physiology, and even natural theology. Further, while joining certain of the arts with the sciences on which they especially depend, he affirmed that certain other arts depend on several sciences at once.[21] This tree was an interesting outgrowth from the Stoic and Aristotelian triads.

Conceptual or arbitrary basic divisions with too little regard for the scope and the relations of the sciences have been the bane of philosophical classifications of knowledge. Because of such division, Francis Bacon, who did so much for method and system in science, failed to establish a valid classification of knowledge. His main division depended on his arbitrary selection of three mental "faculties", memory, imagination, and reason. From memory he supposed history to be derived. But history is not derived from memory alone; and memory is at the root of all knowledge; and reason informs all branches of science and philosophy. Secondly, imagination he took to be the essential of poetry. But is it? And are not other forms of literature and other arts also imaginative? That poetry is mentally akin to history Bacon himself affirmed — especially narrative poetry, which he termed "mere imitation of history", and dramatic poetry, "history made visible". Reason, Bacon reasoned, gives us philosophy, a light unto mankind with three rays, the *direct* ray from Nature, the ray from God, *refracted* by the inequality of the medium betwixt the Creator and the creatures", and man's view of himself by a *reflected* ray. All this is matter of the imagination rather than of the reason, and certainly is not scientific. Closer study of the scheme shows that these branches are interwoven also with those of the memory. But Bacon argued for the unity of knowledge: "The divisions of knowledge are like branches of a tree that meet in one stem."

These are Flint's renderings, true to the Latin text, which reads: ". . . eamque juxta Historiam collocavimus, cum nihil aliud sit

[21] *Cf.* Flint, *Op. cit.*, pp. 98–9; and Shields, *loc. cit.*, p. 58.

quam Historiæ imitatio ad placitum. . . . Narrativa prorsus Historiam imitatum, ... Dramatica est veluti historia spectabilis; . . . ." [22]

As the relations of these writings of Bacon and some citations to them are confusing, it seems well to state the following facts. Bacon's classification of knowledge appears in its most carefully elaborated form in the Latin treatise *De Dignitate & Augmentis Scientiarum Libri IX,* published in 1623, as Part I of the *Instauratio Magna* (the great renewal, or reorganization, of knowledge), of which the *Novum Organum* was Part II, published previously in 1620. The first book of the treatise *De Augmentis* (as it is briefly named) was introductory, giving a survey of the state of knowledge and indicating lacks and remedies. Books II–IX contained *Partitiones Scientiarum.* The many chapters, most of which are short, are introduced with convenient brief epitomes, the most important for our present purpose being: in Liber II the first three and xiii (Poetry), in Liber III Cap. i (Partitio philosophiæ) and Cap. iii, in Liber IV Cap. i and iii, and in Liber VIII Cap. i and iii. In the last we read that Bacon judiciously omitted to discuss politics, or political philosophy: "Partitiones Doctrinæ de Imperio, sive Republica, omittuntur. . . . In hac parte . . . silentium mihi imperavi."

Bacon's previous work, *The Advancement of Learning,* was published in 1605 in English. Its two Books were not divided into chapters but merely provided with subject or paragraph headings in the text. In Vol. II of Montagu's edition this work was reedited, with corrections and with an extended analysis, which was reduced to tabular form on a folded sheet following it. Some years later, Bacon had *The Advancement* translated into Latin and its second Book enlarged and divided into eight. Subsequently these were adapted to the purposed *Partitiones Scientiarum,* and the entire discourse was reissued with certain changes as Part I of the *Instauratio Magna* and entitled as cited above. "I have thought good to procure a translation of that book into the general language, not without great and ample additions, and enrichment thereof, especially in the second book, which handleth the partition of sciences; in such sort, as I hold it may serve in lieu of the first part of the Instauration, and acquit my promise in that part." (Quoted in the preface to Vol. VIII of the edition cited, — on its page viii).

The later translations of the *De Dignitate & Augmentis Scientiarum* rendered this title in the English *On the Dignity and Advancement of Learning.* It appears that the translators took more from the earlier work than its title. It is true that these translations conform more closely to the Latin of 1623 than to the English of 1605; but it seems very likely that the second edition of *The*

[22] *The Works of Francis Bacon,* London, 1825, v. 8, p. 121. Montagu, ed.

Advancement in English in 1629 and the third, revised, edition of 1633 may have adopted many changes from the Latin version. The Table mentioned above as following the Analysis in Montagu's edition of *The Advancement* should not be mistaken for a synopsis of the later elaborated *Partitiones Scientiarum.*

From these facts we can see why the outlines given in the several historical surveys from which we quote or cite are not quite clear and not quite correct, particularly in the terminology, where there is intent to modify or modernize. The tables in Edwards', and in Shields' book are both inadequate and incorrect, but Richardson's is better, and Brown's is best, so far as it goes. That in Pearson's *Grammar of Science* is somewhat confusing.

History Bacon regarded broadly as descriptive science of the specific, the particular, and the individual. He divided it into Natural History and Civil History. Natural History he subdivided into that of Generations (things generated naturally, normally, or *freely*), Præter-generations (abnormalities, "monstra", or "errores naturæ"), and Arts, "vincula naturæ", in which nature is *bound* to man's works and machines. Under the term *generations*[23] he subsumed: 1, Celestial bodies (astronomy); 2, Meteors, including comets, and "regions of the air" (meteorology in its olden scope); 3, The Earth and Sea (physiography); 4, The Elements, fire, air, water, and earth (rudiments of geognosy and chemistry); and 5, Species, or natural kinds, of plants and animals, etc. (natural history in the narrower sense). Regarding natural kinds he said that, if we know one of the kind, we know all of that kind.[24] By a second principle, that of use and purpose, he then divided History into Narrative and Inductive. The former gives "knowledge of things themselves" (descriptive) and the latter the crude (empirical) material ("materia prima"), on which philosophy is grounded. This latter he deemed lacking in his time. Civil History he subdivided into three, Sacred, or Ecclesiastical, Civil History proper, and History of Letters and Arts.[25] The subdivision of Civil History he then elaborated thru several subordinations, which we need not recapitulate here.

Under Poetry Bacon did not, like Aristotle, include other arts, but merely the subdivisions: Narrative, Dramatic, and Parabolical, or Allegorical. The Parabolical he extolled above the Dramatic,

[23] In the original English work the terms are simpler: "History of Nature is of three sorts; of nature in course, of nature erring or varying, and of nature altered or wrought; that is, history of creatures, history of marvels, and history of arts." (*Loc. cit.*, p. 102).

[24] The Latin is more concise: ". . . . ut, si, unam nôris, omnes nôris." (*Op. cit.*, p. 88).

[25] "Litterarum et Artium" appears plainly in the Latin original (p. 99). This must provide for different arts than those included in the third subdivision of Natural History. In *The Advancement of Learning* History is divided into *four* kinds, Natural, Civil, Ecclesiastical, and Literary.

which, important and esteemed in ancient times, he said, was become degenerate.[26] And that was in Shakespeare's day.

Science, or Philosophy in the broad sense, or the sciences, Bacon divided into Theology and Philosophy. Theology there meant Revealed, or Inspired, Theology; and he treated it in the last Book. Philosophy in the second sense he said has three objects, God, Nature, and Man. The first study comprises Natural Theology. Natural Philosophy he subdivided into Theoretical (*speculativa*) and Practical (*operativa*), the former comprising Physics and Metaphysics, and the latter Mechanics (physical) and Magic (metaphysical), the last being also experimental. Physics he divided into three parts, the first treating of the Principles of Things, the second considering the Structure of the Universe and of Things, and the third dealing with things, whether separately or in their relations (*"de Naturâ sparsâ sive fusâ"*). This last he subdivided into Concrete things and Abstract things, the former being the physics of creatures and substances in whatever *accidents* and therefore akin to Natural History, and the latter being the physics of natures and their properties, or accidents, in whatever substances and so related to metaphysics. Mathematics he made the "great Appendix of Natural Philosophy both speculative and operative (practical)". All this was true and wise, and it anticipated important modern divisions.

The Philosophy of Man he divided into two branches, that of the Human and that of the Social, or Civil, the former branch comprising both the body and the soul, or mind, and the arts of Medicine, Cosmetics, Athletics, Hygiene, etc., and the study of the mental (psychology), Logic, Grammar, Rhetoric, Criticism, Pedagogics, Ethics, etc.; and the latter branch comprising three studies, the Art of Conversation and Social Intercourse, the Art of Negotiation (business), and the Art of Government and Politics, also Jurisprudence and Law. These seem too narrowly conceived, but they are not very clearly outlined. In truth Bacon is not remarkable for clearness in these *Partitiones Scientiarum*.

Bacon's great place in the history of thought and his express purpose to systemize justify our giving so much space to his scheme. It differed fundamentally and in detail from all the preceding schemes. Its relation to Aristotle's division appeared, however, in several subordinate divisions; but the Stoic triad and the *trivium* and *quadrivium* were submerged in the details. In the prominence of History in the broad sense Bacon's classification was especially radical. In the

[26] See Book II, Chapter xiii, in the translations.

subdivisions of this subject and of the sciences of Physics and of Humanity this system contributed much of value, but even in these fields its faults outweighed its merits. For scientific and for bibliographic purposes its arbitrary divisions produced inconvenient separations and inconsistent allocations. Some of the most salient of these are the separation of Physics under Natural History from Physics under Natural Philosophy, the wide separation of Anthropology from Natural History, and of Theology from Philosophy and from Natural Theology; and of Poetry on the one hand from Literary History and on the other hand from Rhetoric; and of Logic from Philosophy, and of Civil Philosophy from Civil History; and then the collocation of Ethics with Logic and with Grammar, and of Mathematics with Metaphysics, Magic, and Anthropology, instead of with Logic and Physics.

Campanella, like Bacon, made history prominent, regarding it as comprehending all description of the particular. Knowledge in any study advances from the particular to the general, from the adjacent and the immediate to the derivative and the remote, from the descriptive to the theoretical. In affirming this he was truly scientific. To separate, as Bacon did, the theoretical from the descriptive and historical is to misconceive this development of knowledge. But Campanella in dividing science into *human* and *revealed* on the ground that history is so divided confused the latter branch with theology and impaired his scheme with separations not less unscientific than those of Bacon. Apart from this fault, his classification showed a notable advance on the Aristotelian and Stoic basis. Human Science he divided into Natural and Moral. In Natural Science he comprised Geometry, Cosmography, Astronomy, Astrology, and Medicine; and in Moral Science (like Aristotle's Practical Philosophy) he placed Ethics, Politics, and Economics. Above all he likewise placed a philosophy of principles, or metaphysics. "Campanella, as well as his great English contemporary, endeavoured not only to recall men from an old and false to a

new and true method of scientific inquiry, but to map out the provinces of knowledge according to their natural order and relationship . . . in holding that a classification of the sciences ought to have regard to their objective aspects, their own natures, their inherent characteristics, he took up the only right position; . . . ." [27]

Hobbes followed Bacon and Campanella in distinguishing historical and descriptive knowledge from theoretical and philosophical; but he did not, as Bacon did, make this the basic division of his system. Like Campanella, he regarded the descriptive and historical as entering into all knowledge. He brought forward the notion of progressive stages of knowledge in all branches. Thus theoretical physics is not separate from, but developed from and generalized from the descriptive physical data. There are descriptive and elementary stages of physical knowledge and theoretical and philosophical stages. This is an important principle to bear in mind with regard to the classification of knowledge.

Science, or Philosophy, Hobbes divided into Natural Philosophy and Civil Philosophy; Natural into General sciences and Physical; General into Philosophia Prima and Sciences of Motion and Quantity; the latter into Mathematics and the Sciences of Bodies in special; the last into Cosmography and Mechanics; the former of these into Astronomy and Geography, while to the latter he related the applications, Engineering, Architecture, and Navigation. In the Physical Sciences, proceeding thru several peculiar divisions, he comprised the very broad range of sciences, including some of the humanities: Meteorology, Sciography (suggestive of the modern Astrophysics), Astrology, Geognosy, Mineralogy, Botany, Zoology, Anthropology, Optics, Acoustics (including Music), Ethics, Linguistics, Rhetoric, Logic, and the Science of the Just (equity). Civil Philosophy he divided only once: Rights and Duties of the Body Politic, and Rights and Duties of the Subjects. These two might be termed Philosophy of the State and Civics. Some of these terms are here substituted for Hobbes' quaint definitions. Theology he deliberately excluded. Psychology he ignored. Logic he separated from Philosophia Prima. Economics he omitted. Ethics he separated from the Science of the Just.

[27] Flint, *Op. cit.*, pp. 100 and 102.

Space does not permit us to do justice to the remarkable classification displayed in Hobbes' table.[28] It proceeds by dichotomy thruout, evincing the disadvantages of that method; but it is true in many important respects; and it is not merely an improvement on Bacon's system, and on Campanella's, and on that of their precursor, Reisch, but it is the first system that in a very real sense approaches to the order of modern science.

Comenius, more definitely than Hobbes, treated knowledge as being developmental in successive stages in the pedagogic sense. Dominated by religious intent, he put forth in the seventeenth century an encyclopedic system, which he termed *Christian Pansophy*. This is not a naturalistic tree, but a theological temple of knowledge, thru whose seven halls in succession the mind of youth was to be conducted. The first was introductory, *Templi sapientiæ propilæum;* the second, the *Porta,* opened to the primary studies of all subjects; the third, *Primum atrium,* led to the exhaustive study of visible nature (the natural sciences); the fourth, *Atrium medium,* afforded knowledge of man's body and mind; the fifth, *Atrium internum,* implanted wisdom of man's moral nature; the sixth, *Sanctum sanctorum,* inspired contemplation of God's nature; and the seventh, *Fons aquarum viventium,* was devoted to the dissemination of the Divine wisdom.[29]

This was distinctively serial and approached toward the pedagogic order as speciously as the schemes of Reisch, Campanella, and Hobbes approached toward the scientific order. The series adumbrated here is: elementary studies, natural sciences, anthropology and psychology, ethics and sociology, theology and philosophy. However incomplete, this is right scientifically and pedagogically.

[28] See Hobbes' *Leviathan,* as reprinted by The Clarendon Press, Oxford, 1909, particularly Chapter V.

[29] Flint, *Op. cit.,* pp. 116–17.

CHAPTER XVII

FROM LEIBNIZ AND KANT TO ARNOTT AND AMPÈRE.

1. WHERE GREAT PHILOSOPHERS MISCONCEIVED AND FAILED.

Leibniz made an unphilosophic library classification of nine classes, three being specially for the faculties of Theology, Jurisprudence, and Medicine. Wolff's system was an interesting precursor of Spencer's. Kant dichotomized into metaphysical mazes logically untenable and unscientifically impractical. Krug got unconscionably mixed up in his divisions. Oken's uncouth scheme was criticised by Spencer as "a pseudo-scientific cosmogony." Hegel's tripartite system, tho more modern than others developed from the Stoic triad, was transcendently ultra-philosophic.

The eminent philosopher, LEIBNIZ, who had been also a librarian, made a library classification of nine classes, providing for the three university faculties of Theology, Jurisprudence, and Medicine, and for Intellectual Philosophy, Mathematical Sciences, Physical Sciences, Philology, History, and Miscellaneous. Like the library classification well known as the Decimal, which also places Theology first and History last, this arrangement may have been practical in a way, but it was unscientific and unphilosophic. It shows advance, however, toward completer systemization in making Jurisprudence, Medicine, and Philology more prominent than preceding systems. But these three studies were separated from the sciences to which they are most closely related.

The philosophy of Christian WOLFF, who lived farther into the eighteenth century (1754) than Leibniz (1716), Flint said, "was essentially encyclopedic. It sought to include and absorb all science." It distributed all knowledge in three main divisions, Historical, Mathematical, and Philosophical. Philosophy Wolff divided into Metaphysics, (com-

prising Ontology, Cosmology, Psychology, and Natural Theology), and Practical Philosophy, (including Ethics, Economics, and Politics). "These sciences he regards as following in natural order from more general and simple to more special and complex." Logic he treated as propædeutic to both branches of Philosophy. In these features the system is a significant precursor of Spencer's, and is very interesting in its combination of the Aristotelian division of Philosophy with the prominence of History brought out by Bacon and Campanella.

KANT'S *Critique of Pure Reason* contained a chapter entitled "The Architectonic of Pure Reason", in which the philosopher developed a classification remarkable, like that of Hobbes, for its dogged dichotomy. Fundamentally he distinguished *Rational* from *Empirical* knowledge, and, by a second differentiation, from *Historical* knowledge.

Kant's third division reads thus in Müller's translation: "All knowledge of reason is again either based on concepts or on the construction of concepts, the former being called philosophical, the latter mathematical." Then Philosophy is either *pure,* or *empirical;* [1] and pure philosophy is divided into *propædeutic,* also called *critic,* and "the system of pure reason (science) . . . called *metaphysic*". Metaphysic he divided into the *speculative* (of nature) and the *practical* (of morals). The metaphysic of Nature consists of *transcendental philosophy* and the *physiology of pure reason.* The former means about the same as *abstract ontology;* the latter, the rational principles of the study of nature, may be either *immanent* or *transcendent,* and this may be either of the world (cosmology) or of God (theology). Immanent physiology treats of corporate objects (physic) and of thinking objects (psychology). "Thus the whole system of metaphysic consists of four principal parts: 1. Ontology, 2. Rational Physiology, 3. Rational Cosmology, 4. Rational Theology. [2] The second part, the physiology of pure reason, contains two divisions, namely *physica rationalis* and *psychologia rationalis.*" At last at the ninth stage of division we come to these special sciences, or rather to their disembodied spirits, the *rational principles* that informed the living substance of *empiri-*

[1] This crosses the first main division — and also contradicts it.

[2] This ignores the *Practical* (moral) main division of metaphysic. (See nine lines above.) And the whole system of dichotomy is unclear and confused.

cal data that Kant separated from them. Empirical physics, physiology, and psychology, as parts of Empiric Philosophy, he severed from those conceptual counterparts. Here is a series of sciences of *pure reason,* there is a series of empirical and applicable sciences, most irrationally divorced — to change the figure of speech — from their very pure spouses on the supposition that they are too impure for philosophic companionship. And this decree Kant indeed made absolute: "The fundamental idea of a philosophy of pure reason prescribes itself this division. . . . For that very reason such a division is unchangeable and of legislative authority."

"For the rest, we ought in the whole metaphysical treatment of these objects to abstain from all empirical principles, . . . Empirical psychology, therefore, must be entirely banished from metaphysic, ..." [3]

To such lengths, or depths, philosophers can go. So much space would not here be given to Kant, were he not by some regarded as a master of synthesis as well as of analysis. But the divisions epitomized above are worthless as a basis for the classification of the sciences. The rational and the empirical, and the descriptive and the historical, are altogether inseparable in knowledge and in thought. As for concepts and the synthesis of concepts, not only *rational* knowledge but *all* knowledge develops from them.

Wilhelm Krug, a successor of Kant, in an encyclopedic scheme contrasted the natural sciences, as *free,* with the *bound,* or *positive,* sciences, as dependent an authority, these being in two groups, the Positive Theological and the Positive Juridical sciences.

The Natural Sciences he divided into three groups, each with two subdivisions: (1) Empirical, comprising (a) Philological and (b) Historical sciences; (2) Rational, comprehending (a) Mathematical and (b) Philosophical; (3) Empirico-rational, subdivided into (a) Anthropological, (b) Physical. Besides these, a third main division he termed Mixed Sciences, comprising (1) Politico-economic and (2) Medical Sciences.[4] This is all too much "mixed". It is a mixture of bad philosophy, bad science, and bad art. The empirical should not thus à la Kantienne be unmixed from the rational; nor should the historical sciences be unscrambled from the

[3] *Critique of Pure Reason,* tr. by Max Müller, v. 2, pp. 727, 728.
[4] Flint, *Op. cit.,* pp. 139–40.

political-economic and the anthropological. And are not the philological just as rational as the anthropological, and these just as empirical as those; and are not *all* empirico-rational? Our reason for noticing this scheme is merely to show how mixed some philosophical divisions are, and to point out the analogy of Krug's terms for his three main divisions to Herbert Spencer's main divisions: Abstract, Concrete, and Abstract-concrete, — about which there will be much ado.

A few years later a famous German professor, Lorenz Oken, put forth a preposterous metaphysical classification, which Herbert Spencer chose as an object of his scorn. Part I, Mathesis (doctrine of the Whole), comprised Pneumatogeny (immaterial totalities) and Hylogeny (material totalities); Part II, Ontology, comprised Cosmogeny, Stöchiogeny, Stöchiology, and Kingdoms of Nature; Part III, Biology, divided into Organogeny, Phytosophy, and Zoösophy. These and other terms invented for this scheme have overburdened it with valueless cargo. But it is hardly fair to criticise this as a classification of the sciences, for, as Spencer said, "It is a pseudo-scientific cosmogony, . . ." [5]

The acme of German idealism was attained in the Encyclopedia of Hegel. In this system the whole of reality was conceived as being in the Absolute Idea. All phenomena, all concepts, all systems, all sciences, are portions of that ideal whole; for present purposes they may be disengaged from the relations in which they subsist, but these are partial and temporary aspects, and ultimately they are comprehended in the Universal, in which they originated. In the ideal universe purpose is universal and knowledge is unitary. There are, however, three aspects, or conditions, of the Absolute Idea: the subjective, or self-conscious, the objective existence of the universe, and the introspective study or contemplation of itself as universal and creative Spirit. Accordingly there are three points of view for knowledge, for science, or for philosophy: the epistemological, the naturalistic, or realistic, and the psychological, or anthropological, or humanistic. To these three aspects correspond three general sciences or branches of philosophy: Logic (in the broadest sense), Natural Science, and the Anthropological, or Psychological, or Mental, Sciences. As knowledge is not merely

[5] *The Genesis of Science*, p. 10.

individual but social, and ultimately universal and absolute, and as it progresses by stages from the particular to the general, so these three main branches of philosophy are intersected by three stages of development in the reality they progressively comprehend. Thus Logic comprises the Science of Being (Ontology), the Science of the Essence (Theology), and the Science of the Notion, or Concept, (Epistemology and Logic in the restricted sense). The Philosophy of Nature divides into three sciences of graded specialization, Mechanics, Physics, and Organics (Biological Sciences). And the Philosophy of Spirit (psychology) is differentiated into Subjective studies and Objective studies and the Doctrine of Absolute Spirit; the first of this triad comprises Anthropology, Phenomenology, and Psychology; the second group, Jurisprudence and Law, Ethics and Morals; and the third, Art, Religion, and Absolute Philosophy.[6]

A scientific classification of the sciences should be attained by a synthesis of the sciences with regard to their central concepts, their contents, their scope, and their relations to one another, especially their dependence. It should be rooted in nature and in experience, not brought down from the clouds of a metaphysical system. This does not mean that an idealistic classification would inevitably be unscientific, but that, in so far as scientific, it would embody the order of nature tho viewed in the reverse aspect, the epistemological. This Hegel's system comes near achieving, but does not. For there is no group of sciences that can properly be comprehended by the term *Subjective*. And Mathematics can not be subsumed either under the Science of Concepts or under the Natural Sciences.

Aside from his ultra-philosophical divisions, however, Hegel's order of the sciences was not incompatible with the order of modern science; and his system was indeed synthetic and unitary. It was a great advance on the triadic basis of the Greek philosophers. Ethics had in the develop-

[6] Flint, *Op. cit.*, pp. 155–6.

ment of the sciences and the humanities long since become too narrow a term for the human, or mental, or social sciences and arts. But neither is Hegel's term Philosophy of the Spirit appropriate for this division. Nor is triadic division truly rational; it is indeed artificial; and triadic division is a distinctive feature thruout this system. A scientific and philosophic classification would, however, adopt dichotomy and triadic division only where compatible with the very relations of the several sciences and branches of knowledge.

2. THE ARTS AND THE SCIENCES.

The distinction between arts and sciences was not clear in Plato and in Aristotle; nor was it much clearer in the medieval "liberal arts", nor again in Bacon's system. Hobbes and Bentham correlated the arts with the sciences on impractical principles carried to extremes. Coleridge "mixed" the arts with correlative sciences. The Fine Arts were first systemized by Baumgarten and by Sulzer.

The third branch of the Aristotelian triad was assigned to Productive Sciences or Arts, of which Poetics was the representative art and which probably was originally intended, as the term *poetics* then implied, to comprise all the useful and the fine arts as well as those of language. The terms *arts* and *sciences* were somewhat confused in the writings of Plato and Aristotle and their followers, even as the terms *science* and *philosophy* were often used indiscriminately for the several distinct branches of knowledge.

Cassiodorus distinguished the trivium as *artes,* or *scientiæ sermocinales,* from the quadrivium as *disciplinæ,* or *scientiæ reales;* but this distinction was not always maintained in the succeeding centuries, and the two groups of studies were commonly called "The seven liberal arts". But in modern times more than one *science* has developed from origins in the quadrivium.

To the seven Isidore added other arts and technologies, without precisely distinguishing these; but Hugo did distinguish a group of seven technical and mechanical arts. Konrad GESNER conceived more broadly of the term *arts,* as

appears in his general heading: "Philosophia comprehendit artes et scientias". His encyclopedic work [7] was by Edwards named as the first bibliographical system. Gesner's twenty-one books are given as follows:

1, Grammatica et Philologia, 2, Dialectica, 3, Rhetorica, 4, Poetica, 5, Arithmetica, 6, Geometrica, Optica, etc., 7, Musica, 8, Astronomia, 9, Astrologia, 10, De Divinatione et Magica, 11, Geographia, 12, Historia, 13, De diversibus artibus, 14, De naturali philosophia, 15, De prima philosophia, seu metaphysica, et theologia gentilium, 16, De morali philosophia, 17, De philosophia œconomica, 18, De re politica, 19, De jurisprudentia, 20, De re medica, 21, De theologia Christiana. The first four he termed *Sermocinales.* They correspond to the *trivium* with Poetica added. The next five, corresponding to the *quadrivium,* he termed *Mathematicæ.* The tenth to the thirteenth were *Ornantes,* the last of these being the Arts. The remaining eight, by Gesner termed *Substantiales,* comprised the branches of philosophy, beginning with the Natural and ending with the Political, and the three academic "faculties", Jurisprudence, Medicine, and Christian Theology, which Leibniz later made the first three divisions of his bibliographical system.

Bacon provided for some arts under Natural History and under Natural Philosophy, Practical; and for others under the Philosophy of Man. These groups roughly correspond to the mechanical and technical arts, to those of magic and medieval "metaphysic", and to the arts of life (medical, hygienic, cosmetic, etc.) and of society, business, and politics.[8]

Hobbes more definitely correlated certain arts with the sciences chiefly applicable to them; thus to Mechanics he assigned Engineering, Architecture, and Navigation; and to the science of Light he correlated Applied Optics, and Music to the science of Sound.

The knowledge of the Fine Arts was not brought into the circle of studies until BAUMGARTEN in the middle of the eighteenth century in his *Æsthetica* first gained a coördinate place

[7] *Pandectarum sive Partitionum universalium libri xxi,* Tiguri, 1548–9.

[8] The terms *Arts and Sciences,* joined in this order, appear several times in *The Advancement of Learning.* See pp. 177–81 of the edition by Montagu, (cited on p. 315).

for this subject. A few years later SULZER first gave a comprehensive view of the fine arts in their relationships to one another and to their related sciences.[9]

It was BENTHAM, the utilitarian, who in 1816 in an Appendix to his *Chrestomathia,* discussing classification, more generally and more positively claimed for the arts coördination, or at least correlation, with the sciences to which they are so effectually related. ". . . . art and science so run along everywhere together that every division performed on the one may, on any occasion, be considered as applying to the other." This extreme statement may be considered in the light of what was said on the subject in our chapter on Science. Tho the arts and sciences are in general interdependent, they are not parallel all along the series; there are some arts that do not belong to any particular science. Music is more than applied acoustics, and Painting more than a study of light, and Navigation has to do chiefly with other courses than those of the stars and planets. If the arts indeed depend on applied knowledge, then their importance should justify assigning to them a main branch of the system to include those that do not belong under any one special science.

Bentham's classification, starting from a unity of art and science, which he termed Eudæmonics, and which was hardly less universal than Hegel's Idea, exemplifies the error of excessive logical bifurcation, which in his case ramifies thru a grotesquely cumbersome terminology of Greek derivatives. Space permits us not to do justice to it here, but the reader may be amused to learn that Bentham's dichotomic definition of Arithmetic is Gnostosymbolic, alegomorphic, poroscopic, somatic, cœnoscopic ontology.[10]

Mixed and Applied Sciences is the term used in COLERIDGE's classification as embodied in *Encyclopædia Metropolitana,* of which he was chief editor. Tho not so badly mixed

[9] Flint, *Op. cit.*, p. 136.
[10] More of this kind of stuff may be seen in Flint's book, p. 164.

as Krug's scheme, the complexities of technology were by no means mastered by the poet of "Kubla Khan". His Division I, Pure Sciences, was subdivided into (1) Formal Sciences, including Grammar, Logic, Rhetoric, Mathematics, and Metaphysics, and (2) Real Sciences, comprising Morals, Law, and Theology. In Division II, Mixed and Applied Sciences, the term *Mixed* covers the Physical Sciences, and under the term *Applied* are specified Experimental Philosophy, Fine Arts, Useful Arts, Natural History, and Applications of Natural History. But are the physical sciences less pure than the *Real* sciences, or are they more mixed? Division III, Biographical and Historical, especially evinces the modern encyclopedic purpose.

In recent times The Congress of Arts and Science at St. Louis in 1904 prominently brought these terms together in its name, its purpose being mainly the coördination and unification of the branches of science. The system of this great Congress will, however, be considered in a subsequent chapter.

3. THE HISTORIC ENCYCLOPEDIAS AND DICTIONARIES.

Encyclopedic philosophic systems were followed by encyclopedic works of reference, especially in the eighteenth and nineteenth centuries. Some were like dictionaries; some were systematic; and there have been several intermediate forms.

The earliest encyclopedias purported to be, as their names implied, comprehensive surveys of the circle of studies; but their knowledge was still very crude, and their surveys were likely to be less circular than their arguments.

The encyclopedic purpose was, however, offset by increasing popular interest in the knowledge of facts, not the erudition of scholars nor the science of savants, but information of what was being, or had been, said and done in the world, details of all kinds, historical, biographic, scientific, and technical. Thence arose in the latter half of the seventeenth century a succession of *dictionaries* of terms and topics alphabetically arranged for convenience of reference.

The famous Greek lexicon that under the name of SUIDAS dates back to the eleventh or twelfth century contained much historical, biographical, and geographical information. But the first work to bear the title *Dictionnaire historique* was that of MORÉRI (1674). To improve on this BAYLE compiled his *Dictionnaire historique et critique* in two volumes, 1695–97. The English pioneer was HARRIS' *Lexicon Technicum, or an Universal Dictionary of Arts and Sciences* (1704). But this was a different field, in which the dictionary of FURETIÈRE, including "les termes de toutes les sciences et des arts", had been the precursor in France, soon followed by *Le Dictionnaire des arts et des sciences,* compiled by Thomas Corneille for the French Academy in 1694 to supplement their great dictionary of French, which excluded scientific and technical terms. "A long series of dictionaries of arts and sciences have followed Corneille in placing in their titles the arts before the sciences, which he probably did merely in order to differ from Furetière.[11]

This order was adopted in Ephraim CHAMBERS' famous *Cyclopædia, or, an Universal Dictionary of Arts and Sciences,* in two volumes, 1828, and in most of its successors in English. There may have been reason for this in the growing interest in industrial arts and technology, later manifested in the great exhibitions or fairs. These *dictionaries* are mentioned here to show that the Arts, and especially the technologies, had in the two centuries between Bacon and Bentham come to be recognized as important in the fields of knowledge.

The *dictionaries* tended to become encyclopædic in the sense that they furnished information from the whole circle of studies. The age of conversation, the eighteenth and nineteenth centuries, was supplied with copious materials from the dictionaries and encyclopedias for the gatherings of gilded

[11] *Encyclopædia Britannica,* XI ed., v. 9, p. 373. We should remember, however, that in this order Cassiodorus had distinguished the *trivium* as *artes* from the *quadrivium* as *scientiæ reales.* This distinction may have become vaguely traditional. The same order recurs in Bacon's *Advancement of Learning.*

society in the French salons and for the "table-talk" at the English dinners and in the London coffee-houses.

The greatest of these encyclopedic dictionaries was the famous French *Encyclopédie, ou dictionnaire raisonné des sciences, des arts, et des métiers,* edited by DIDEROT and D'ALEMBERT and published in 1751–80 in 35 volumes.[12] This was designed not only as a *dictionnaire raisonné* of the details of sciences and arts, but also as an encyclopædia exhibiting the order and system of knowledge. D'Alembert made a scheme of classification for it, adapted from Bacon's, but altered as follows.

Under History he placed Sacred first, next Ecclesiastical, third Civil, and Natural last, whereas Bacon had more logically placed Natural first and Civil last. Under Philosophy he placed Metaphysics, or Ontology first, next Theology (Science of God) and there subordinated not only Natural Religion but Revealed, which Bacon had placed last of all; and a third subdivision of Theology he termed Science of Good and Evil Spirits, distinguishing it from Natural Religion and from Ethics. The third division of Philosophy he made Science of Man, and the fourth Science of Nature, whereas Bacon's order had been God, Nature, Man. The Science of Man D'Alembert subdivided into Pneumatology (psychology), Arts of thinking and communicating, etc. (Logic, writing, printing, grammar, rhetoric, etc.), and Morals (ethics), under this term including, like the ancients, Politics, Jurisprudence, and Commerce (economics). Under Poetry he included the Fine Arts. To Mathematics he gave adequate recognition, making it a subdivision of the Science of Nature coördinate with Physics, which he treated more consistently than did Bacon.[13]

We need not consider how far this classification was embodied in the *Encyclopédie,* or in its successor, *Encyclopédie méthodique et par ordre des matières,* which, begun soon after by PANCKOUCKE, about 1782, was continued by AGASSE till completed in 1832.

[12] A very interesting account of the vicissitudes of the *Encyclopédie,* whose editors, as radicals, incurred the antagonism of the Church and the opposition of the government, is given in *Encyclopædia Britannica* in a single paragraph, which, by the way, is the longest on record, filling three columns of the article "Encyclopædia".

[13] The table in Edwards' book, previously cited, may be compared with Flint's analysis (*Op. cit.,* pp. 143–7), which is followed here only in part. Flint said that under Natural History D'Alembert "gives a very elaborate distribution of its objects and of the uses to which they might be applied in arts, trades, and manufactures. This was an important addition to the Baconian scheme."

It comprised 51 parts in 166 volumes, numbering 124,210 pages, with 6439 plates. There were dictionaries, supplements, and appendices, with 88 alphabets, 83 indexes, and 166 introductions, discourses, etc. For Geography there were three dictionaries and two atlases. Medicine had a dictionary of 13 volumes, being the largest of the special dictionaries comprised in the entire work.

A diverse development was the encyclopedia of special treatises, of which COLERIDGE'S *Encyclopædia Metropolitana,* mentioned in the preceding section, was a leading example. The purpose here was not merely systematic, but indeed to furnish a repository of information.

Nearly two centuries earlier (in 1630) ALSTED'S *Encyclopædia septem tomis distincta* arranged seven divisions of knowledge in seven volumes containing 35 books for as many subjects or subdivisions, as follows: [14]

I. Præcognita disciplinarum: 1, Hexilogia, 2, Technologia, 3, Archeologia, 4, Didactica: four books on intellectual habits and on the classification, origin, and study of the arts.
II. Philology: 5, Lexica, 6, Grammar, 7, Rhetoric, 8, Logic, 9, Oratory, 10, Poetry.
III. Theoretic Philosophy: 11, Metaphysics, 12, Pneumatics (spirits), 13, Physics, 14, Arithmetic, 15, Geometry, 16, Cosmography, 17, Uranometria (astronomy and astrology), 18, Geography, 19, Optics, 20, Music.
IV. Practical Philosophy: 21, Ethics, 22, Economics, 23, Politics, 24, Scholastics (education).
V. The three Superior Faculties: 25, Theology, 26, Jurisprudence, 27, Medicine.
VI. Mechanical Arts in general: 28 Mathematical (physical) Mechanical Arts, 29, Agriculture, baking, brewing, metallurgy, mining, etc., 30, Various Physical Mechanical Arts, e.g. Printing.
VII. Ferragines disciplinarum: 31, Mnemonics, 32, History, 33, Chronolgy, 34, Architecture, 35, Miscellaneous Arts, e.g. Magic.

Very interesting is this, and truly systematic. It bears considerable resemblance to Gesner's system; but its first volume is different, and it places the "three faculties" in its fifth division,

[14] *Encyclopædia Britannica, loc. cit.*, p. 372. Flint erroneously stated that Alsted's edition of 1630 was in two volumes folio, tho he could hardly have overlooked "septem tomis" in the title. He praises the work highly (*Op. cit.*, p. 114).

whereas Gesner places them last; it gives even more room to the several groups of arts, and it specifies Scholastics, anticipating Education. The Aristotelian divisions, Theoretical and Practical, appear in its third and fourth divisions. The *trivium* is included in its second division, and the *quadrivium* in its third, with other physical sciences.

By alphabetical arrangement of the special treatises, discourses, and articles the purposes of the systematic encyclopedia were in certain later works combined with those of the dictionary form. The first of this type was *An Universal History of Arts and Sciences,* published in 1745 by Dennis COETLOGON in London in two volumes. In this a treatise on Ethics was placed under the letter E, and one on Logic under L, and so forth. One of the most extensive developments of this type was a German series of monographs published from 1818 to 1890 in 167 volumes entitled *Allgemeine Encyclopädie der Wissenschaften und Künste, in alphabetischer Folge,* edited by ERSCH and GRUBER.

Between this extended form of the alphabetical encyclopedia and the opposite development of the systematic or classified encyclopedia, compendium, or *handbuch* of from two to forty volumes of elaborate and complicated arrangement of parts and sections there have been intermediate forms which we need not specify here. *Encyclopædia Britannica* exemplifies the systematic encyclopedia tending to the dictionary. On the other hand *La Grande Dictionnaire Universelle* of LAROUSSE, 16 vols., quarto, 1865–78, and *The Century Dictionary, an encyclopedic lexicon,* exemplify the dictionary tending to become encyclopedic.

4. CONCEPTUAL SYSTEMS OF SCIENCE.

Arnott truly distinguished the four most important fundamental sciences in proper order. Ampère developed the first commendable detailed classification of the sciences, tho conceptually it had basic faults. Proudhon conceived a ternary system. Merlin outlined a library classification in remarkably correct order. Cournot made a futile attempt to combine Bacon, Comte, and Ampère.

Concurrent with the great development of natural science in the nineteenth century, many conceptual systems of science were put forth, some of which harked back to Bacon, and some even to Aristotle; others, however, were quite original.

Like Bacon, Dr. Neil ARNOTT in his once well known *Elements of Physics,* published in 1827, distinguished natural history from natural science, which together, he said, make up all our knowledge of nature, the former being the descrip-

tive component, the latter the theoretical, or abstract, summation, or generalization. All natural kinds and phenomena and all truths or laws of nature "are referable to four distinct classes, which we call Physical, Chemical, Vital, and Mental." Mathematics he treated as ancillary to science. Theology he included in the mental sciences. The arts, as the various applications of the sciences, he correlated with the four fundamental divisions; and they are included in his "Table of Science and Art".[15] Considering the dependence of the subsequent sciences on those preceding them in the above series, Dr. Arnott compared the series to a pyramid, Physics being at the base. Thus in some measure he anticipated the hierarchy of Comte, from whose earlier lectures he may have derived the idea. To say the least, his was a step in the right direction.

Ampère, the illustrious scientist, was the first to construct a systematic and detailed classification in commendable conformity with the conceptual structure of naturalistic science. All branches of knowledge, whether sciences or arts, he regarded as distinct for definition and for classification, as are the objects of natural science. The most important he first classified according to their contents, purposes, or relations; [16] these he termed *Sciences of the First Order,* and subdivided them into *Sciences of the Second Order,* and again into *Sciences of the Third Order.* Thus Botany he subdivided into an Elementary branch and Phytognosy, and the latter into Phytonomy and Vegetable Physiology. But, in

[15] *Elements of Physics, or Natural Philosophy,* 5th ed., London, 1833, Introduction, pp. xi, xiv, and xviii. See also Flint's criticism, *Op. cit.,* p. 173–5.

[16] ". . . . les deux principaux moyens de charactériser une science et de fixer les limites qui la séparent de toutes les autres, sont, d'une part, la nature des objets qu'on y étudie; d'autre, le point de vue sous lequel on considère ces objets. Ce n'est qu'en combinant ces deux moyens de définition et de classification, qu'on peut espérer de trouver l'ordre en lequel elles s'enchaînent le plus naturellement, et les réunir en groupes de différens ordres, daprès leurs véritables analogies." — Ampère, André Marie. *Essai sur Philosophie des sciences, ou exposition analytique d'une classification naturelle de toutes les connaissances humaines.* I. Partie, 1834, II. Partie, 1843. 2 vols., Paris. The quotation above was taken from p. 12 of the reissue of Part I in 1838.

addition to this subdivision, while involved in it, he distinguished four stages of development, to which he gave Greek names with which we need not trouble the reader. Like Comte he held that these stages are not only historical but pedagogical. The study of this kind of purposive, systematic classification he termed Mathésiologie, and assigned it to the second order of Pædagogics.

Ampère overburdened his system with forbidding Greek terminology. Thus the Moral group he divided into Ethics and *Thélésiologie,* which, he said, treats of the nature of the will, the rules of duty, and the end of man.[17] Under this science of the first order he accordingly named the four sciences of the third order: *Thélésiographie, Diciologie, Morale apodictique,* and *Anthropotelique.* This is putting a heavy masquerade on this companion of Ethics, tho not quite so bizarre as the harlequin of Bentham.

Every science of the first order he regarded as comprising two of the second order and four of the third order. He divided the Cosmological Sciences from the Mental, or Noölogical, Sciences (Bentham's term). Each of these "kingdoms" he divided into two "sub-kingdoms", and each of these into two branches, and each branch into two sub-branches, each containing two sciences of the first order. These in each of the four sub-kingdoms were numbered from 1 to 8, that is, there were 32 in all; and under each of these the four sciences of the third order were numbered by adding the digits 1 to 4. The four sub-kingdoms he termed: A, The Cosmological proper, B, Physiological, C, Noölogical proper, and D, Social. His eight branches, or groups, were: I, Mathematical, II, Physical, III, Natural, IV, Medical, V, Philosophical, VI, Noötechnique, VII, Ethnological, VIII, Political. With some changes in terminology, this would approach to the order of modern science. But nature is less symmetrical than this represents her to be; she observes order and conforms to laws, but she does not go on consistently dividing by two.[18]

Yet Ampère termed his system *naturelle,* and he supposed that in constructing it he had proceeded from the particular to the general, as naturalists do. His chapters of exposition show evidences of such method, but the resulting system, especially as seen in the large folding table in his book, is very artificial and is overworked beyond scientific requirements. "La plus savante de toutes les classifications des sciences, mais la plus artificielle, est celle d'Ampère." [19]

[17] *Op. cit.,* II. Partie, p. 40.

[18] *Cf.* Flint, *Op. cit.,* p. 188.

[19] Paul Janet, *Principes de Métaphysique et de Psychologie,* Tome I, p. 102.

In this system the arts were correlated and coördinated with the respective sciences more consistently than by Alsted, Hobbes, Bentham, and Arnott. Technology was placed after Physics, and after Geology came Technology of Mineral Production (bearing the Greek derivative *Oryctotechnie,* from ὀρυκτα, minerals); then Agriculture followed Botany, and after Zoölogy were placed *Zoötechnie* and the Medical Sciences. This is contrary to Comte's doctrine that only the fundamental sciences should be coördinated in series, an opinion held later by Masaryk, Shields, Naville, Janet, and others. We have taken middle ground between the two extremes, subordinating special technologies to the respective sciences and coördinating some of these technologies with branches of those sciences, and coördinating with fundamental sciences the class Fine Arts and the residual class Useful Arts. (See the Table on p. 302).

Aside from the faults pointed out above, there is much to commend in Ampère's system, which was a great advance on those of Hobbes and Arnott. It was one of the first to give proper recognition and place to Geology and Psychology. Its influence was indeed long felt in France; and we find Janet in 1897 resting largely on Ampère. It is a pity that this gifted modern scientist, having put so much knowledge into his system, should have so failed to lay a durable foundation. But dichotomy, the bane of classification, dichotomy, which any good logician uses guardedly, was the rock that split the scientific ship of Ampère, as it wrecked the eudaimonic argosy of Bentham and the cloudy metaphysical canvas of Kant.

In 1842–7 there was published in Paris the catalog of the library of Sylvestre de Sacy, by R. Merlin, "based upon the logical classification of the sciences". So well was this done that there is much less to criticise than in the systems of the eminent scientists, Ampère and Spencer. As a conspectus, it was nearer to modern science than the American library classifications in vogue at present. Prominently exhibited in tabular form in a book well known to librarians, Edwards' *Memoirs of Libraries,* it should have shown the way to its successors. In the table marked XI on the folded sheet inserted in his volume II, after p. 810, this system is outlined as follows:

I. Polygraphy.
II. Philosophy.
III. Theological sciences.
IV. Cosmological sciences.

1. Mathematical sciences.
2. Physical sciences.
3. Astronomical sciences.
4. Geological sciences.
5. Mineralogical sciences.
6. Phytological sciences.
7. Zoölogical sciences.
8. Anthropological sciences.
   Individual Man.
      Physical.
      Moral.
   Society.
      Social sciences.
      Historical sciences.

This did not, however, bring out Psychology, Economics, Arts and technologies, and Philology. Merlin apparently subsumed Psychology under Philosophy, as also Logic, which thus would be separated from Mathematics by the Theological literature. Indeed the point of view was philosophic rather than scientific, for all the sciences were subsumed under the term *Cosmological.*

The French scientist, COURNOT, attempted to combine features of the incompatible systems of Bacon, Arnott, Comte, and Ampère.[20] Like Bacon, he separated the descriptive and historical from the theoretical. Like Comte, he arranged the theoretical sciences in a series, designating five groups: mathematical, physical, biological, noölogical, and political sciences. Like Ampère, he divided his system into two main divisions, I, Cosmological and historical, and II, Theoretical (but this differed from Ampère's II, Noölogical). While adopting much of Ampère's classification, he avoided his systematic and elaborate bifurcation. Like Arnott, he separated the arts and technologies, in a third main division, from the theoretical sciences on which they respectively depend. He can hardly be said to have succeded in his purpose. "Few of his groups seem to comprehend just the sci-

[20] In his *Essai sur les fondements de nos connaissances,* Tome II, Chapter xx–xxii (1851).

ences which they ought to contain; but the distribution as a whole has very great merits." [21] We may accept this last word without the two that precede it.

[21] Flint, *Op. cit.*, p. 214.

CHAPTER XVIII

COMTE'S GRADED SERIES AND SPENCER'S ABSTRACT–CONCRETE DIVISION.

1. COMTE'S "HIERARCHY"

A nearly correct series of fundamental sciences of decreasing generality was Comte's main contribution. He also gave Sociology its status therein. But he failed to recognize Psychology as a fundamental science. Abstract and concrete components he distinguished in the several sciences. Successive historical dependence, or *filiation*, he argued, was inherent in his "hierarchy."

To August Comte belongs the credit of having established more definitely than Reisch, Hegel, Arnott, and Ampère an order of fundamental sciences, which, after one or two important amendments, appears to be permanent, because well grounded in the order of nature. The series was as follows: Mathematics, Astronomy, Physics, Chemistry, Biology, Social Physics (Sociology).[1] It has several faults, the most important being that Psychology was not recognized there as a fundamental science. And Logic, the critique and analysis of knowldge, Comte discredited as futile, formal mental exercise, and, tho he appreciated the value of method in science, he seemed "to give up as impracticable the main problem of Logic, properly so called.[2] But Mathematics, which he deemed to be an extension of Logic, he placed at the head as most general, while also most *instrumental*. Rational Psy-

[1] *Cours de philosophie positive,* 6 vols., Paris, 1830-42. The scheme had been outlined, however, in a short program of a *Cours de philosophie positive en 72 séances,* circulated in manuscript in 1826. This was printed at the end of the "Préface spéciale" to the *Appendice générale* to Comte's later work, *Système de politique positive,* 1851–54, tome IV. Still earlier, in May, 1822, his series of fundamental sciences was adumbrated in his *Plan des travaux scientifiques nécessaires pour réorganizer la société,* which was printed on p. 78 of that *Appendice.*

[2] Lewes, *History of Philosophy,* 3rd ed., London, 1867, v. 2, pp. 630–31.

chology was at that time usually treated as a branch of Philosophy. All introspective and speculative philosophy Comte disparaged under the contemned term *metaphysics*. Theology and Metaphysics, he maintained, dominated two earlier stages of knowledge and thought, from which scientific, or positive, philosophy had parted company, confining its present scope to the study of nature and human nature. And this was the range of Comte's fundamental sciences. This series was not comprehensive of all philosophy nor of all science. It was positive philosophy that he purposed to systemize, not all the sciences in detail, nor all studies. Places for Logic, Psychology, Religion, Economics, and Philology could be found, but as subordinate branches. Anthropology was a term that Comte did not adopt, probably because it was then too much infected with metaphysical notions of human nature. Moreover, it was not fundamental in the Comtean sense but composite of parts of Biology, Psychology, and Sociology. To Physiology Comte subordinated what was then the early stage of empirical psychology, terming it "Physiologie intellectuelle et affective".

The term *psychology* had been used by Kant and by Hegel for branches of philosophic study. The mind, or soul, of man and the intimations or manifestations of spirits had its earlier philosophy, or metaphysics, definitely recognized by Bacon, Reisch, Comenius, and others, and termed *Pneumatics* by Alsted and by Leibniz. The kindred term *Pneumatology* was by Bentham and by D'Alembert used in a broader scope, as was the term *Science of Mind* by Arnott, who adopted the term *Pneumatics* for the science of "airs", or gases.[3]

Comte was less addicted to bifurcation than was Ampère, but his series arose from a succession of dichotomies. All knowledge he divided into *theoretical* and *practical;* then, disregarding the practical, he divided Theoretic science into *natural philosophy,* or *physical science,* and *metaphysical,* discarding the latter opposite. Theoretical natural science he divided into *abstract,* or general, and

[3] The transition in usage appears in 1656, when Blount spoke of pneumatics as the science of "spirits, or the winds", and in 1660, when Boyle wrote of the narratives of certain physical experiments as "our new pneumaticks". Hutton in 1806 defined Pneumatics as science of "air, or elastic fluids". (*Oxford Dictionary*).

concrete, or particular, this being nearly equivalent to descriptive and historical knowledge. "We must distinguish between the two classes of Natural Science; — the abstract, or general, which have for their object the discovery of laws which regulate phenomena in all conceivable cases; and the concrete, particular, or descriptive, ... whose function it is to apply those laws to the actual history of existing beings." [4] Physical science he subdivided into *inorganic physics* and *organic physics,* and the former branch into *celestial physics,* or Astronomy, and *terrestrial physics,* or Physics (special physics), while organic physics he subdivided into *physiology,* or Biology, and *social physics,* or Sociology.

A salient fault emphasized by many critics was the placing of Astronomy ahead of Physics. Astronomy indeed is not a fundamental science but is dependent on Physics as well as on Mathematics, is more special, and is more composite. Comte, however, regarded Astronomy as mainly a development of what Laplace had called "méchanique céleste". Under this and under *rational mechanics,* which he had subordinated to Mathematics, he apparently would have comprehended most of general physics. What he briefly termed *Physics* in his series must have been for the most part what we now sometimes contradistinguish as *special physics,* which is no more a fundamental science than is Astronomy. Thus his treatment of Physics is from our present point of view inadequate and inconsistent. The criticism urged by Mill, Spencer, and others should, however, have been qualified by some such considerations as these.

Similarly unfair is the objection that in describing Physiology as a fundamental science he magnified a mere branch of Biology to that important position. It is true that in his two introductory chapters and in the two tables that appear there and in the Programme of his *Cours* in 1826 he did inconsistently give Physiology as the name of the fundamental biological science. This conspicuous use has proved misleading to his critics. But the name *Biologie* appears no less prominently as the running headline of Book V of his major work, and in the text *passim,* either so or as *la science biologique;* and he made it plain that he regarded physiology as a branch, or rather a mere constituent portion, of biology.[5]

To social science Comte gave a new status. Thenceforth it was no longer merely the descriptive and historical study of customs and morals, politics and economics. There began to emerge the

[4] (Martineau's translation, New York, 1855, p. 41). This is true enough to the French original, v. 1, p. 86. *Cf. re* Bacon *supra* p. 319, *re* Campanella, p. 320, and *re* Hobbes, p. 321.

[5] For instance, on p. 310 of vol. 3 he wrote: ". . . . que la biologie philosophique doit s'efforcer d'établir cette harmonie constante et nécessaire entre le point de vue anatomique et le point de vue physiologique." And on p. 313 ". . . . la vraie position de la biologie dans ma hiérarchie encyclopédique."

principles of the new science of Sociology, the methods of which were not only historical but biological and also physical, in the broadest sense of these terms. This and more is implied by the name Social Physics and its component Social Statics, or the theory of the *order of society,* as distinguished from Social Dynamics, the theory of the *natural progress* of society. The sciences of human society were no longer to be circumscribed as "the moral sciences", or Ethics.

It is remarkable that with his humanistic point of view Comte should have produced a naturalistic series without Anthropology. A more complete Anthropology would have included Ethics and Religion as products of human nature, and also Art and Language as no less requiring recognition in a naturalistic view; for, as we have affirmed before, the humanistic merges into the naturalistic.

The several sciences Comte regarded as composed of abstract and concrete components or counterparts. The fundamental sciences he held are all abstract in so far as they can be abstracted from the concrete data and components. His table showed subdivisions, but he proposed to consider chiefly the fundamental, abstract, and general.[6] His doctrine of the correlation of the abstract and concrete in the several sciences was stated in a succinct generalization by Lewes: "Abstract Science then is the knowledge of the elementary facts, or Laws of phenomena; Concrete Science is the knowledge of objects as actual combinations of these elements." [7]

The order is one of decreasing generality, he declared, and also of increasing complexity; and moreover it is the order of historical development and of pedagogic sequence. Each science in the series depends, he asserted, on those that precede it in the series, but not on those that follow it. This is the idea of "filiation", from which arose the notion of the "hierarchy of the sciences". This dependence, however, he did not, as his critics impute, regard as invariable. These claims have been the subject of considerable controversy. Spencer and Fiske demolished the theory that the sciences

[6] ". . . . réduire nos considérations à l'étude des sciences générales, sans embrasser en même temps les sciences descriptives ou particulières." (v. 1, p. 74.) See also Martineau's translation, pp. 41–2.

[7] *Op. cit.,* p. 601.

had developed historically wholly in that order. Littré and Mill defended Comte in at least part of his doctrine. Lester Ward more positively justified the principle of filiation, which Spencer had denied. We shall recur to this in criticising Spencer. Our basic views of the questions involved were stated in Chapter XII, § 3 and § 4.

2. SPENCER'S UNTENABLE DIVISIONS.

The distinction between *abstract* and *concrete* Spencer misapplied to *divisions* by which he falsified his classification, tho his series of fundamental sciences was less faulty than Comte's. In his argument against serial dependence he was inconsistent, tho partly right. A master of synthesis, he failed in this problem.

Herbert SPENCER purposed and achieved a more comprehensive synthesis than Comte, a synthesis of *science,* of which he had affirmed the unity. He was less *positive* than Comte in disregarding Philosophy, nor did he exclude studies partly scientific because he sensed that they were contaminated with "metaphysics". In Spencer's system Psychology was for the first time brought out prominently as a fundamental science. His classification was thruout more elaborate. When cleared of its faults, it presents a valid advance on Comte's series. Together these two have contributed most to establish the order of the sciences now accepted in the scientific and educational consensus. But in its main division this system was much more faulty than that of Comte.

Comte's distinction between abstract science and concrete science as component of the several sciences, major and minor, Spencer misapplied to the sciences entire and furthermore made the basis of his division of science into three classes, or groups, of sciences, the Abstract, the Abstract-concrete, and the Concrete. These he regarded as being not merely logically distinct but really separate. "If then these three groups of sciences are, respectively, accounts of *aggregates,* accounts of *properties,* accounts of *relations,* it is manifest that the divisions between them are not simply perfectly

clear, but that the chasms between them are absolute." [8] This is inconsistent with his argument for the unity of knowledge, of science, philosophy, and art, in his earlier essay, *The Genesis of Science,* in 1854, in which he condemned not only Comte's but all serial classification of the sciences. Yet his own division implied serial subordination, and the classification that he reared upon it readily reduces to the serial form.

But we are concerned in classifying the sciences chiefly because this aids us to *systemize* them; we are concerned in their individual and group relations to a series of fundamental sciences graded in speciality rather than in their relations to any classes that may be formed of them.

When Spencer proceeded to classify the sciences, he forsook simplicity and invested his structure with the overpowering majesty of the abstruse. "The broadest natural division among the sciences, is the division between those which deal with the abstract relations under which phenomena are presented to us, and those which deal with the phenomena themselves." Abstract sciences he distinguished, as being "concerned with the ideal or unoccupied forms of relations", from the "Sciences concerned with real relations, or the relations among realities". The Abstract-Concrete sciences he defined as "those Sciences which treat of realities, not as they are habitually manifested, but with realities as manifested in their different modes, when these are artificially separated from one another". The Concrete he described as "the Sciences which, taking these modes of Being as they are habitually connected with one another, have for the terms of their relations, those heterogeneous combinations of forces that constitute actual phenomena". Such distinctions may subsist in thought, but they divide no sciences. It is questionable to set up any divisions in science, but to ground them on such definitions as those is altogether futile. "Relations of whatever orders", he perversely wrote, "are nearer akin to one another than they are to any objects. Objects of whatever orders, are nearer akin to one another than they are to any relations".[9] But there is nothing so close in thought, or in science, to a

[8] *The Classification of the Sciences,* p. 103. This essay was first published in 1864 and was reprinted in the second volume of Spencer's *Essays,* with little change. The citations in these footnotes refer either to the English edition of 1891 or to the American edition of 1892, which is apparently from the same plates. Spencer seems to have had his own ideas of punctuation, which led me to compare passages quoted to make sure that the printers were not to blame.

[9] *Ibid.,* pp. 76, 85, 88, and 77.

relation as the things it relates. This is evinced by the constant confusions in philosophy between relations and *relata*. As Flint observed, the moral relations have less to do with mathematical relations than with *moral conduct*, that is, with the *data* of ethics. This is not merely a question of terminology but of definition. With phenomena, or realities, *all* sciences deal, except Logic and Mathematics in their most abstract propositions. On the other hand, *all* sciences involve abstract relations, else they would not be science. The relations may be abstracted from the things related in different degrees of abstractedness; and the sciences may be so graded. But, if Spencer meant that his abstract sciences dealt with nothing but relations abstracted from all realities, then they would not be sciences in the sense of knowledge of reality.[10] The sciences treat of the things related *and* the relations involved. The things may be realities, or phenomena, or concepts, but all have empirical grounds in reality, and they ultimately rest on what Spencer meant by realities, or phenomena. The term *abstract*, we must conclude, is inappropriate for division or classification of the sciences, tho it may be applied to a gradation of sciences.

The second class of Spencer's division is defined in no less untenable terms. The Abstract-concrete sciences, as treating of elements, properties, or factors, of phenomena, or of realities, he distinguished from the Concrete sciences, as treating of totalities, aggregates, or products.[11] All these terms apply rather indiscriminately thruout the whole range of science and thus are valueless for division, or for definition. There are "elements" and "factors" in the "concrete" sciences of psychology and sociology, and by the same token there are aggregates, totalities, and products in the mathematical and physical sciences. The Abstract-concrete sciences have abstract and concrete components. The Concrete sciences too have their abstraction — all of them, tho in different degrees. Did Spencer write his treatises on Psychology and Sociology without abstractions?

Amid these inconsistencies it appears that Spencer's overwrought distinction between the abstract and the concrete as applied to the classification of the sciences, either reduces to

[10] "So wenig wie es von der Chemie richtig ist, das sie es bloss mit Relationen, und von der Astronomie, dass sie es bloss mit Objecten zu thun habe, ebenso wenig kann die Mathematik als eine Wissenschaft der reinen Relationen bezeichnet werden. Vielmehr beziehen sich ihre Begriffe ebensowohl auf Gegenstände, wie auf Verhältnisse von Gegenständen. Ein Dreieck z. B. ist eine gegenständlicher Begriff, während eine arithmetische Operation, eine analytische oder geometrische Function eine Relation enthält, die freilich, wie jede Relation, Gegenstandsbegriffe voraussetzt." Wundt, *Ueber die Eintheilung der Wissenschaften*, p. 25.

[11] *Op. cit.*, pp. 78, 93, and 103.

the principle of *gradation,* or series, which he repudiated, or else proves signally false as a basis of division. On this false basis he proceeded to divide and subdivide by dichotomy; and in cumbersome dichotomy and abstruse definition he outdid Hobbes and Bentham, Kant and Hegel. His four tables show that nearly every division is bifurcate. These tables are awesome things to look upon.

If, however, all this dichotomy be disregarded, and those definitions, the resulting *series* of sciences is indeed less faulty than that of Comte — and more complete — as follows: Logic, Mathematics, Mechanics, Physics, Chemistry, Astronomy, Geology, Biology, Psychology, and Sociology. This is a good series, except that Mechanics should be subordinated to Physics.[12] Furthermore Economics would have an equal right with Mechanics, Astronomy, and Geology, to a distinct place among the major sciences, and so would Ethics, Æsthetics, and Philology.

Another patent inconsistency inheres in Spencer's contention that there is "no true filiation" of the successive sciences in the series, while he argued that: "The first, or abstract group, is *instrumental* with respect to both the others; and the second, or abstract-concrete group, is *instrumental* with respect to the third or concrete group. An endeavour to invert these functions will at once show how essential is the difference of character. The second and third groups supply subject-matter to the first, and the third supplies subject-matter to the second; but none of the truths which constitute the third group are of any use as solvents of the problems presented by the second group; and none of the truths which the second group formulates can act as solvents of problems contained in the first group." [13] These three groups are thus regarded as of three grades of dependence, that is, they form a series. Within each of these groups the several sciences have been successively dependent, Mathematics on Logic, Physics on Mathematics, Chemistry on Physics more than on Mathematics, Astronomy and Geology on all the preceding, tho especially on Physics; Biology on Chemistry more than on Physics, and Psychology on Biology, especially on Physiology; and Sociology more on Psychology than

[12] This latter term appeared not in Table II, but in the preliminary table on p. 78.

[13] With these passages quoted from *The Classification of the Sciences,* p. 93, compare p. 27 of *The Genesis of Science,* in the edition cited.

on Biology. One could hardly expect such complex things as sciences more fully to evince serial dependence, or "filiation". The term *filiation,* however, seems objectionable because it implies genetic dependence or developmental descent; and on that side the dependence is less evident, as Spencer showed. But he inconsistently adopted that idea, together with the idea of serial dependence, in later pages of his essay, as the following passage will show: "To resume, then, is it not manifest that in the group of sciences — Astronomy, Geology, Biology, Psychology, Sociology, we have a natural group that admits neither of disruption nor change of order? Here there is both a genetic dependence, and a dependence of interpretations. The phenomena have arisen in this succession in cosmical time; and complete scientific interpretation of each group depends on scientific interpretation of the preceding groups." [14]

In these arguments Herbert Spencer does not appear to advantage. He was self-stultified by inconsistencies. As Mill said, he has not succeeded in making out a case. He did not differ enough from Comte to make such a fuss about it. "Mr. Spencer would seem", Flint caustically remarked, "to have himself constructed a series of sciences of the very kind which, in opposition to Comte, he declared to be impossible. Comte meant no more by calling one science logically dependent on another than that the one placed first is instrumental as regards the one placed last, while the latter is not instrumental as regards the former. . . . Mr. Spencer started with denying that there was any such series, but ended by implicitly showing that there was one. . . . So far from having succeeded in overthrowing that scheme, he only at the utmost succeeded in slightly modifying it." [15]

What was the outcome of all the controversy? Comte was nearly right in his series, tho his arguments were partly unjustified. Spencer, tho partly right in his arguments, was unjustified in his contentions that "a *serial* arrangement of the sciences is a vicious one" and that: "There is no 'true *filiation*

[14] *Loc. cit.*, p. 96.

[15] Flint, *Op. cit.*, p. 231. See also Lewes' *History of Philosophy,* 3rd ed., London, 1867, v. 2, pp. 607 and 653, where we read: ". . . . Mr. Spencer has on several occasions expressed his dissent from Comte's views, sometimes indeed exaggerating the amount of difference in vindicating his unquestionable originality, and implying an antagonism which does not exist."

of the sciences' ".[16] And the classification that he set up in opposition, tho nearly right *as a series,* was in its divisions fundamentally wrong. Most regrettable is it that Spencer, who was in so many ways competent for the great undertaking, should have so profoundly failed in this purpose. A master of synthesis as well as of analysis, a constructive scientist of high rank in several sciences, notably in Psychology, Sociology, and Ethics, he presented with unsound arguments a false classification unworthy of his best capabilities.

3. THE ABSTRACT-CONCRETE BLUNDER PERSISTENT.

Bain criticised Spencer's divisions and rejected his *abstract-concrete.* He distinguished concrete sciences, as *derived,* from the abstract, fundamental, or " departmental." He further distinguished the *practical* from the *theoretical.* Tho unsatisfactory, his classification was the best so far. Karl Pearson's system, based on conceptual divisions as untenable as Spencer's, was more abstruse and confused. In part it implied cross-classification; but it reduces to a series nearly like Spencer's, tho with faults of its own. Masaryk combined several of the foregoing principles in virtual cross-classification, but with inconsistencies.

The sciences may be graded by speciality, or generality. As the terms *general* and *abstract,* tho not synonymous, are correlative, we may accordingly say that the sciences may be graded by their relative abstractness. Yet this term, because of the difference in connotation, is not appropriate to the series of decreasing generality, and it is still less applicable to division of the sciences into groups. There is some truth, however, in Spencer's division of Logic and Mathematics, as dealing mostly with abstract relations, from all other sciences, as dealing supposedly with realities. Moreover there is considerable truth in his second division, for his Abstract-Concrete sciences closely correspond to the relatively abstract and general physical sciences. Furthermore his Concrete sciences are, it is true, those that have as yet developed less of the theoretical and abstract and are mainly descriptive, statistical, and historical. These admissions granted, those divisions were, we repeat, misconceived, invalid, and inappropriate. We shall now see how the blunder persisted.

[16] The writer's own views are given in Chapter XII, § 3.

Alexander Bain, while he trenchantly criticised the use of the terms, and more especially the abstract-concrete division, himself adopted the classes Abstract and Concrete; but he applied the terms differently — more like Comte. Abstract science, he held, treats of relations or properties without regard to particular, individual, and accidental differences; a concrete science is one that "classifies and describes one great department of actual or concrete things. . . . a certain group of *locally* allied phenomena is separated for special study. . ." "A science embraces a *distinct department* of the world, or groups together facts and generalities that are of a kindred sort." "The abstract is also the simple, the concrete the complex."[17] Bain further distinguished the abstract sciences as *fundamental,* and the concrete as *derived.* He employed the term *departmental,* not quite consistently, now as comprising both the abstract and the concrete, and now as coinciding with the fundamental. In these sections Bain's usual clearness was lacking, and his statements seem rather offhand.

The *fundamental* sciences in Bain's classification were the following: I, Logic, II, Mathematics, III, Mechanics, or Mechanical Physics, IV, Molecular Physics, V, Chemistry, VI, Biology, VII, Psychology. In discarding Astronomy and Sociology from this series Bain differed reasonably from both Comte and Spencer; and again from Spencer in placing Geology not with the fundamental but with the derived sciences. His *concrete,* or *derived,* sciences were: Special and Applied Mechanics, Astronomy, Meteorology, Mineralogy, Geology, Geography, Botany, Zoölogy, Human Anatomy and Physiology, Sociology, Politics, and Philology. He might have included others, but he does not make that clear. Nor does he give these in serial form. In addition to all those he marked off the *Practical* Sciences as opposed to the Theoretical (abstract and concrete).

[17] *Logic, Deductive and Inductive,* Introduction, §§ 39–41, also Appendix A.

"The final end of all knowledge is Practice, or the guidance of conduct. There are numerous departments of practice. Another name for practice is Art. . . . Art may be empirical or it may be scientific. . . . Art becomes scientific, when science is brought to bear upon it. Navigation, ... Engineering, Building, Machinery, Dyeing, etc. . . . may be called Scientific Arts, or Practical Sciences. Another group (connected more with mind) includes Ethics, Logic (in its practical aspect), Æsthetics, Rhetoric, Grammar, Education, Politics, Jurisprudence, Law, Political Economy. . . . Several of the subjects last named might be viewed either as Theoretical Concrete Sciences, or as Practical Sciences. . . . In a Practical Science, the knowledge is selected and arranged purely with reference to the subject in view. . . . is selected from one or more theoretical sciences, and set forth in the order suited to the end in view." [18]

These sentences are extracted from Bain's pages because they present his important contribution in connecting the more special concrete sciences and the arts and technologies with the series of fundamental sciences; for these too belong to the classification of knowledge. Herein his system effected a very considerable advance beyond those of Comte and Spencer, which had too little regard for these subordinate and derived branches of knowledge and study. In separating, however, all technologies or scientific arts from the correlative fundamental sciences and their concrete branches, Bain constructed a system that, tho logical indeed, was not natural nor scientific, as compared with that of Ampère. We have indicated before the reasons for placing the more scientific technologies subordinate to the sciences on which they are chiefly dependent and putting those that are mostly empirical together in a residual class of Useful Arts.[19]

Bain's subdivisions are somewhat confused and his statements are not always clear enough, but it is implied that the three orders, Fundamental sciences, Derived, and Practical, virtually compose a cross-classification, the seven fundamental, or departmental, sciences standing in a vertical column and the other two orders being correlated more or less

[18] *Loc. cit.*, § 43.
[19] *Cf. supra*, p. 296.

closely in parallel columns. It is regrettable that he did not give a table so arranged.

It should not be overlooked that Bain failed to give proper recognition to Metaphysics, Religion, and Theology, and to Anthropology, which last is scientific, more so than Politics, which he included.

The best classification so far (1870) we are, however, disposed to pronounce Bain's, despite its faults. Ampère's, maugre his dichotomy and his forbidding Greek terms, was the best up to his day (1834). Whether Spencer's was on the whole better than Ampère's is a question that might be answered according to the point of view. In division and cross-classification Ampère's seems better than Spencer's. Reduced to a series, Spencer's seems better than Ampère's. But Bain's one may agree with Flint in declaring better than Spencer's and also better than Ampère's. None of them is satisfactory in the light of science developed since.

Karl Pearson, according with Spencer as to the unity of science and the interdependence of its branches as well as the complexity of their development, sustained him in denying the validity of the serial order of the sciences. Like Spencer, he obtained by a system of division a scheme of studies too vaguely defined to be adaptable to the organization of knowledge. While his definitions were less cumbersome, some of them were no less abstruse, and his details were even more confused.

He took great pains to distinguish between the perceptual and the conceptual, and he preferred to carry along with him wherever he went a burdensome terminology implying that all these systems are in truth conceptual. His system was therefore somewhat like Whewell's,[20] a classification of scientific ideas or concepts rather than of realities, or the studies that apply to realities. Yet his point of view was neither psychologic nor subjective, but empirical and naturalistic.

His basic divisions correspond closely with Spencer's. He adopted the terms *abstract* and *concrete*, defining them even more

[20] See p. 369.

abstrusely: "The former group deals with the conceptual equivalents of the modes under which the perceptive faculty discriminates objects, the latter with the concepts by aid of which we describe the contents of perception." [21] This he elsewhere reduced to the antithesis, "modes of perception" and "contents of perception", substituted for Spencer's *relations* and *realities*. Now empirically all knowledge is indeed the conceptual development of the "contents of perception". The sciences that deal with the "modes of perception" would not be the abstract sciences of logic and mathematics, but just psychology and the methodology of science. Pearson's Concrete thus included the field of Spencer's Abstract-Concrete, which he regarded as the objectionable feature of that system. So, if one maintained with Bain, Wundt, and Shields [22] that the purely abstract, or formal studies, as dealing with abstract relations only, are strictly not sciences at all, then *all* the sciences would be *concrete*. That is not to say that they deal with the concrete only or merely with the contents of perception; for Pearson is careful to define them as dealing with the concepts that have developed from those perceptions and by which we "describe the contents of perception". But how do such concepts develop? By the process of abstraction, as every logician well knows. So we might as well say that all the "concrete" sciences are essentially *abstract*. Again this distinction between abstract and concrete sciences falls to the ground.

With that first Pearson linked a second division, Precise and Synoptic. These terms are about equivalent to the preëxistent terms *exact* and *descriptive*. Some sciences are more exact and others less so. If we could estimate how much so in regard to the several sciences, we could accordingly arrange them in a series graded by their exactness. But the most exact sciences are the *abstract* sciences. As regards the term *descriptive*, Pearson reiterated that all science is descriptive.[23]

Pearson's third division rests upon the antithesis between the living and the lifeless; his Concrete Science therefore bifurcated into Inorganic and Organic, the former equivalent to the physical sciences and the latter to the biological. The latter branch is mostly synoptic. Pearson's tables accordingly present a series of groups of sciences: (A) Abstract, (B) Inorganic Concrete, or Physical, subdivided into (1) Precise Physical Sciences, and (2) Synoptic Physical Sciences, and (C) Organic Concrete Science, subdivided into (1) History, and (2) Biology. The Precise Physical Sciences are nearly the same as Spencer's Abstract-Concrete, with some theoretical chemistry, astronomy, and geodesy thrown in. Here we have Spencer's division over again under guise of new

[21] *The Grammar of Science*, London, 1892, p. 454.
[22] See pp. 388–9.
[23] *Op. cit.*, 2nd ed. (1900), p. 514.

terms. And again we virtually have a series, arguments to the contrary notwithstanding, — a series of decreasing abstractness, or preciseness, or synopsis, or what you will to call it. The Abstract group appears in the table as science of *relations* (Spencer's term), which similarly is divided into the Qualitative (Logic) and the Quantitative (Mathematics), Space relations (Geometry) and Time relations (Kinematics, etc.). The Organic group is subdivided also by space and time relations into (1) Natural History, Ecology, and Geographical Distribution, (2) History of Life and its forms, of Man, and his institutions, (3) Biology, further subdivided into Morphology, Embryology, Physiology, and Psychology, the last comprising Sociology and its subordinate studies, Morals, Politics, Economics, Jurisprudence, etc. This classification is more clearly shown by the tables; and so are some of its peculiar and inconvenient separations of parts of well recognized unitary sciences, such as Biology and Psychology. Space does not permit us to reproduce the three tables, but Pearson's *Grammar of Science* can be obtained in libraries. A few of the separations, however, may well be instanced here. Astronomy is distributed in three different subdivisions of the Physical Sciences. Theoretical Chemistry under the Precise is dissevered from Descriptive Chemistry under the Synoptic. Geodesy is severed from Geography and Geology, and Crystallography from Mineralogy. Physical Anthropology is sequestered from Zoölogy. The theory of Evolution is removed from Morphology, farther from Heredity, and still farther from theoretical Biology. Sociology, on the outskirts of Ultima Thule, is cut off from its distant bases in Social Institutions.

Such are some of the consequences of division by *conceptual differences* that are less applicable in science than in logic, and which, if applied, would result in confusion. Yet from these divisions, from these very tables, there emerges the inevitable series of sciences of graded abstractness, or speciality: Logic, Mathematics, Kinematics, Mechanics, Physics, Chemistry, Geology, Geography, Natural History, Human History, Biology, Morphology, Physiology, Psychology, Sociology, Morals, Politics, Economics, Jurisprudence, etc. Omitting Philosophy, Æsthetics, and Linguistics, and dispersing Astronomy, this series is not just as it should be, but is near to the natural order and it reduces to nearly the same serial order that Comte handed to Spencer and he to Bain. It extends but does not improve much on Spencer's, having some of his faults and some of Pearson's own.

The next system to be considered here was put forth in the Bohemian language in 1886 by no less a personage than the present President of Czecho-Slovakia, Thomas G. Masaryk, who was then a professor in the University of Prague.[24] His primary division was that between Theoretical and Practical; but for his secondary division he took the inapt terms *abstract* and *concrete,* tho he eschewed the term *abstract-concrete,* Spencer's *bête noir.* He differed from Spencer and Pearson in affirming the validity of a series of affiliated sciences. His series of fundamental sciences was the same as Bain's, except that he added Sociology and omitted Logic. This last he placed with two other abstract sciences, Philology and Æsthetics, in a group "outside of the hierarchy", that is, complementary to the fundamental sciences, all of which he regarded, like Bain, as theoretical and abstract. So separated, the sister sciences of Logic and Mathematics would in their present stage of companionship be very unhappy, and especially so would be the logisticians.

Masaryk's Concrete sciences, tho divided from the Abstract and not complementary to them, as in Bain's system, he regarded as interrelated on the one hand with the Abstract and the Theoretical and on the other hand with the Practical. He emphasized indeed the interdependence of all the sciences and arts. This seems somewhat inconsistent with his drastic primary division of the Theoretical from the Practical. His Concrete sciences included: 1, Geometry; 2, Astronomy (Chronology), Acoustics (in part), Hydrostatics, Hydrodynamics, Aërostatics, etc., Cosmography (Astro-, Geo- and Oceanography), Cosmology (Astrogeny, Geology, etc., also Cosmical Physics, Chemistry, Astro-physics and Astro-chemistry, Geo-physics and Geo-chemistry, etc.); 3, Botany and Zoölogy; 4, Concrete Psychology, Ethnology, Political sciences, Political Economy (including Statistics), and History (both Universal and Special); 5, History of Language; 6, Theory of Arts; and 7, Concrete Logic.[25] Are these studies altogether concrete? Have they not

[24] Flint said that the book was "on the classification and organization of the sciences", but the title of the German translation (1887) was *Versuch einer concreten Logik.* I have not found either of these books in the large libraries to which I have applied.

[25] This follows Flint, who said it was thus given by Masaryk. Flint had a high opinion of Masaryk's system and devoted over ten pages to it (*Op. cit.,* pp. 272–283).

their abstractions too? Is there no abstract part of the Theory of the Arts, that it should be separated from Æsthetics in the Abstract division? Nor in Geometry, in Chemistry, in Astrophysics, in Polical Economy? What need is there to divorce Concrete Logic from its better half in Abstract Science? Theology Masaryk did not admit to be a science. Such are the ill-starred consequences of basic divisions on false principles. Classification should bring together, not separate, those things that are similar and related.

This system of Masaryk was a valuable contribution in that it combined several principles of validity, put forth more one-sidedly by predecessors; and it consistently elaborated more detail than most of those had done. It was virtually a cross-classification. The correlative Practical division comprised: Calculation and Measurement, Descriptive Geometry, Industrial and Imitative Arts (study of), Technology, Physical Education, Hygiene, and Medicine, Pedagogy, Politics, Ethics, Practical Grammar, Practical Æsthetic, and Practical Logic. All these divisions and subdivisions would come close to reducing to a cross-classification of knowledge, abstract, concrete, and practical.

CHAPTER XIX

MODERN CROSS-CLASSIFICATIONS AND CONCEPTUAL SYSTEMS.

1. CROSS-CLASSIFICATION PROFESSED.

Fundamental sciences in one series may be crossed by stages of development, of concreteness, of application, etc. The systems of Erdmann, Giddings, Stadler, Goblot, and Naville, each in its peculiar way, exemplify faults of such cross-classification, when misconceived or mismanaged. Some of these systems are also impaired by untenable basic divisions.

Knowledge is progressive and science developmental. The several sciences have stages of development, in which they are progressively more or less general, or generalized, abstract, or theoretical, technical, or applied. Certain sciences are general not only in the sense that they have attained to generalizations and abstractions but in the correlative sense that they comprise a wide range of objects, that is, they are general, or comprehensive, in scope; and, as some of the special kinds of objects, forces, or relations comprehended may also be the materials of other, more special sciences, these general sciences are properly termed *fundamental* with respect to the special sciences that are *derived* from them, and to the *concrete* and *applied* sciences, technologies, and arts that are in various ways dependent on them. Moreover, as *general* and *special* are relative both in comprehension and in definition, so the fundamental sciences are relative both in generality and in dependence on one another, and they may accordingly be arranged in series by their grades of generality, or speciality. In other words, whichever terms and concepts we refer to, we can arrange the fundamental sciences in

a series, as did Comte and Bain. The stages of development, whether historical, logical, or pedagogical, may then be represented as crossing that series in what is termed a cross-classification,[1] sometimes visualized by a checker-board diagram. As we have said before, the systems of Hobbes and Bentham, Hegel, Arnott, and Ampère, Spencer, Bain, Pearson, and Masaryk, were in this sense virtually cross-classifications.

ERDMANN, the eminent historian of philosophy, contributed in 1877 an excellent essay [2] embodying one of the best classifications up to that date. Each science, he said, has arisen from a complex of rudimentary data, the source of a developmental series or group. "Each series is represented by a special discipline" and comprises a group of sciences. There are several divisions of these. The first distinguishes the Abstract, or Mathematical, Sciences from the Real Sciences. The second divides the Real into the Formal, or theoretical, and the Material, or historical. Crossing this is the third division, into Natural, or Physical, Sciences (*Naturwissenschaften*) and Psychical Sciences (*Geisteswissenschaften*): Erdmann did not give a table, probably deeming such too rigid. From the first impression it may seem that the system is serial, with several divisions; but on closer scrutiny it is seen to be neither serial nor dichotomous thruout, but virtually a cross-classification, which may be concisely represented as in the following diagram. Its faults are such as arise chiefly from the division of the theoretical from the historical, and are open to objections similar to those we have brought to bear upon the systems of Bacon, Spencer, Bain, and Masaryk. However we may regard this system as being in general a very good approach to a valid order of the principal sciences and branches of philosophy. Some of its main features recur in the subsequent systems of Wundt and other German systematists.

[1] *Cf. supra,* p. 154.

[2] "Gliederung der Wissenschaften" in *Vierteljahrsschrift für Wissenschaftliche Philosophie,* 1877.

I. ABSTRACT.	II. REAL.	
	A. FORMAL (*or Theoretical*).	B. MATERIAL (*or Historical*).
Mathematics.		
a. Physical (*Naturwissenschaften*).		
	Physics.	Astronomy.
	Mechanics.	Geology.
	Chemistry.	Anorganology.
	Cosmology.	Organology.
		Anthropology, Physical.
b. Psychical (*Geisteswissenschaften*).		
	Psychology.	Pedagogy.
	Epistemology.	
	Logic.	*Other applied psychological, and the Social sciences would be here.*
Abstract but not scientific:	Ethics.	
Metaphysics,	Æsthetics.	
Theology.		

Giddings in his *Principles of Sociology* (1896) incidentally touched upon the classification of the sciences with especial reference to Comte and Spencer. He explicitly advocated a cross-classification, in which the Abstract sciences of Mathematics, Physics, Economics, Ethics, and Politics are graded crosswise on a checker-board plan, and the Concrete sciences, or portions of Chemistry, Astronomy, Geology, Biology, Psychology, and Sociology are graded by speciality and crossed or combined with contents, principles, or methods of those Abstract sciences.[3] Regarding the terms *abstract* and *concrete,* Giddings recognized that they are relative and that they do not properly distinguish whole sciences or classes of sciences. His definition is so clear that it is worth while quoting here.

"We may fix attention on an actual group of relations, properties, and forces, together constituting a perfectly concrete aggregate, and try to understand it and explain it as a whole. This is the method

[3] *Op. cit.*, p. 49. The passages quoted in this connection appear on p. 48. Giddings criticised Comte and Spencer on pp. 46–7, especially Spencer's Abstract-Concrete group.

of concrete science. Or we may fix attention on a relation, a property, or a force, or on a class of relations, properties, or forces, and follow it through all the aggregates in which it is found. This is the method of abstract science. But neither method can be completely carried out without help from the other. Abstraction presupposes concrete knowledge, but the abstraction when attained must be turned back upon concrete knowledge as an organizing principle before we can perfectly understand any aggregate.

"It is therefore more accurate to class a science as abstract if it is concerned chiefly with relations, properties, or forces and only incidentally with aggregates. Molar and molecular physics are abstract sciences. A science is concrete if its chief aim is to explain aggregates as such, though it deals also with properties and forces and uses the methods of abstraction. Chemistry is on the whole a concrete science.

"Thus, instead of one linear series of sciences there are two distinct orders of sciences, so related to each other as to make cross classifications in every part of the intricate domain of knowledge."

The important truth embodied in Giddings' cross-classification is that the sciences are all partly abstract and theoretical and partly concrete and descriptive, and that the concrete parts furnish material to the abstract, while at the same time they rest upon them for principles and methods. Thus biology, psychology, and sociology have some abstract principles and to some extent employ general methods. Besides, while they contribute much to the more special sciences of economics, ethics, and politics, they may contribute something even to the more abstract mathematical and physical sciences. In the checker-board plan there is thus a field for psychological economics, a field for social ethics, and a field for economic biology. But there are limitations to this dispensation. Important relations between sciences are excluded or distorted, if the rules of the game be applied consistently. If Mathematics and Physics are in the same series and thus do not overlap, where does Mathematical Physics come in? If the concrete sciences "become explanatory only because they are traversed, or crossed, by the abstract sciences", then what shall we say of the abstractions of social psychology, of biochemistry, and of geo-chemistry? These are not so crossed

by abstract sciences. Moreover this cross-classification has vacant fields where there are no crossings. Politics has not yet got into Astronomy. Nor is there any chemistry worth speaking of in Ethics. The truth is that, as we have said before, the complicated relations of the sciences and arts are not to be adequately represented by a cross-classification, but rather by the figure of the tree on the trellis. This particular cross-classification is invalid in its basic principles, and it is erroneous in thus placing Biology, Psychology, and Sociology at cross purposes with Economics, Ethics, and Politics. In brief the system will not work. As the abstract and by implication the concrete are correlative to the general and the special in definition (tho not in extension), they may be graded in one series by that principle, but they cannot consistently compose two series in cross-classification.

The system of STADLER, a neo-Kantian German philosopher, embodied a cross-classification of the Natural Sciences, but is especially interesting because this author, emphasizing the inadequacy both of one-dimensional and of two-dimensional schemes, advocated the three-dimensional system more clearly than others had done.[4] What his system lacks, however, is a proper series of fundamental sciences from which his cross-divisions might derive, forming the basis for his three-dimensional subdivisions. Instead of this, successive dichotomies result as usual in inconvenient separations.

The first of these divisions distinguished Knowledge from the Philosophy of Knowledge, the second divided Sciences of Phenomena (*Erscheinungslehre*) from those of ideals and obligations (*Ideenlehre*), the former branching into Natural Sciences and Mathematics, and the latter branching into Teleology and Ethics. The fourth division bifurcated Natural Sciences into those of external phenomena (*Körperlehre*) and those of internal phenomena (*Seelenlehre*), the former comprising five sciences, Cosmology, Astronomy, Geology (*Erdkunde*), Mineralogy, and Biology, the lat-

[4] ". . . sei diese vollständige und allseitige Klassifikation die allein wahre. . . . Klassifikation in allen Dimensionen." Stadler, August. *Zur Klassification der Wissenschaften,* in *Archiv für Systematische Philosophie,* Band 2, 1896, pp. 1–37. For the principle mentioned above see p. 3. Neither Flint nor Richardson correctly represents Stadler's system.

ter comprising the three branches of Psychology; Subjective, Objective, and Comparative. Both these classes of the Natural Sciences were crossed by five divisions, Morphology, Chemistry, Histology, Physics, and History, from which there result the subdivisions of the Physical Sciences and the Psychological Sciences. But some of the places thus crossed are vacant in the interesting table that precedes the text. Histology appears only under Biology; the History of Minerals is omitted. There is of course no chemistry in Psychology, and it is only in the objective branch of this that Psychophysics appears. Under Physics and Chemistry there are three-dimensional branches, Analytic, Synthetic, etc., and perhaps elsewhere. But the order of the five cross-divisions is confused; Physics should precede Chemistry and Histology should precede Morphology. Moreover these divisions are not parallel in principle; history does not parallel physics and chemistry and morphology but crosses them.

This system, commendable in certain respects, is very faulty both in its divisions and its cross-divisions and its resulting separations. Thus Logic under the Philosophy of Knowledge is separated from Mathematics under the Science of Phenomena. Chemistry is separated from Physics, and Education from Psychology. Kinetics, or more properly Kinematics, under Mathematics is separated from Physics under Natural Sciences. Sociology is not recognized — neither under History nor under Biology nor under Psychology, from all of which Economics is separated under Applied Teleology, where Æsthetics is also separated from its nearest of kin. Other faults might be shown, if space permitted.

Edmond Goblot in 1898 set forth [5] with lucid arguments in the spirit of positivism a system that may best be reduced to a two-dimensional basis, a series of fundamental sciences crossed by evolutional and historical-geographical divisions. From Comte he adopted the idea of a hierarchy of general and theoretical sciences, from which there branch dependent special and applied sciences, somewhat as in the systems of Bain and Erdmann. But the general, or pure, sciences he reduced to two, *Physique* and *Bio-psycho-sociologie,* the latter being composite of three sciences which he regarded as complementary and continuous. For the physical sciences he also used the term Cosmologie. This division harks back to Ampère's division of *Sciences cosmologiques* from *Sciences*

[5] *Essai sur la Classification des sciences,* Paris, octavo.

noölogiques. From all these M. Goblot distinguished the Mathematical Sciences, including Rational Mechanics; and these abstract sciences he also termed the *deductive*, or *demonstrative*, sciences, as contrasted with the *inductive*, experimental, observational, and concrete.

Yet he saw that these distinctions of method and stage of development are not proper bases of division. "Les sciences se différencient par leurs notions fondamentales et non par leurs méthodes." (p. 52). His fundamental sciences he regarded as distinct, but not separate, also the classes, Physical, Psychological, Social, and Moral Sciences; it is only the abstract or mathematical sciences that are separate, he maintained, a little inconsistently. (p. 14). And yet he wrote: ". . . la distinction des sciences abstraites, déductives et idéales, et les sciences concrètes, expérimentales et réelles, n'est pas profonde. Elle répond non à la nature intime des connaisances, mais à leur degré d'avancement. . ."[6]

His distinction between Applied Sciences and Practical Sciences resulted in inconsistent separations. His scheme so forcibly illustrates the mismanagement of cross-classification and the resulting inconveniences that it seems worth while to combine his two chief tables here, slightly modified for the purpose in view.

	SCIENCES THÉORIQUES				SCIENCES PRATIQUES
		APPLIQUÉES			
	PURE OU GÉNÉRALE.	Spéciale, Ordre Systématique.	Géographique, Ordre dans l'espace.	Historique, Ordre dans le temps.	ARTS
COSMOLOGIE.	Physique.	Chimie. (et Minéralogie).	Astronomie. Géographie physique.	[Cosmogony] Origine du système solaire. Géologie. Paléontologie. Histoire.	Arts méchaniques.
BIO-PSYCHO-SOCIOLOGIE.	Physiologie. Fonctions organiques, psychologiques, Sociales de tous les vivants.	Biologie. Botanique, Zoölogie, Anthropologie, psychologique, sociale.	Géographie. biologique, linguistique, économique, politique, etc.		Hygiène et thérapeutique, organiques, psychologiques et sociologiques des végétaux, des animaux et des hommes.

[6] *Op. cit.*, p. 52. Compare p. 14 also with pp. 10 and 33.

Special sciences in this system meant sciences of specific properties, kinds, and species, and of the systematic classification of such, especially in the so-called classificatory sciences. The special physical sciences named were Chemistry and Mineralogy. The special biological and social sciences were indicated in the text: Botany, Zoölogy, Anthropology, Economics, Politics, Law, Social Psychology (under the term *Sympathie*). Semantics (a linguistic study), Religion, Logic, Æsthetics, and Morals, were discussed as more or less distinct parts of the general science, Bio-psycho-sociology, or of Sociology, or as *applied* sciences derived from this *pure* science. Hygiene and Therapeutics, as *practical* sciences, M. Goblot separated from the *pure* science of Physiology and the *applied* science of Anthropology. Logic he went so far as to subsume under Sociology, reasoning that: "*La science* est un phénomène social, et, par conséquent, la logique est une branche de la sociologie". The term *Géographie* for the spatial order is inapt; for Descriptive Astronomy, which must be brought under that term, Goblot even employed the terms "La Géographie du ciel". Whether theoretical astronomy would be separated from this "geographical" branch is not indicated, nor, if so, where it would find place. Physical Geography in the same field may have meant Physical Geology, for Geology in the historical column should apply only to Historical Geology. Properly following this in the historical column, Paleontology shared with History the immense field of Historical Bio-psycho-sociology. This kind of division and cross-classification is indeed impractical.[7] Regarding the primary division of Theoretical from Practical, it may be objected that Geography, and History, and even Mineralogy, are hardly more theoretical than Hygiene and Therapeutics.

Adrien NAVILLE'S *Nouvelle Classification des Sciences*, published in 1901,[8] was indeed a new adaptation of Spencer's triadic basis under new terms and new arguments.

The author, appreciating that abstraction is not distinctive, termed his first division "*Théorématique*, sciences des limites universelles et des relations nécessaires des possibilités, ou *Sciences des lois*, including:

[7] M. Goblot published in 1922 a second book on this subject, *Le Système des Sciences*, which was free from many of the objections made to the earlier work and which indeed is one of the best books on the subject. In this he makes less of the divisions and classes of the sciences than of the relations in which they are systemized. This book is more critically mentioned in the Bibliographic Notes, (p. 415).

[8] This was "Deuxième édition, entièrement refondue", of a work published in 1888.

1. Nomologie, the abstract science of laws of science;
2. Sciences mathématiques: Arithmologie, Géometrie, Cinématique;
3. Sciences physiques: Méchanique, Physique, Chimie, Biologie;
4. Sciences psychologiques: Psychologie, Sociologie (linguistique, économique, etc.).

These sciences Naville regarded as all being theoretical, the sciences of laws, of theorems. They arise from the question, or problem, what is *possible* in certain given conditions? It is only in this class, he affirmed, that there may be serial arrangement by decreasing generality, or increasing complexity, or *filiation*, or successive dependence.

History Naville made his second main division, "Histoire, science des possibilités réalisées, ou *Science des faits*"; and he regarded this as in one sense unitary but at the same time a group of sciences, subdivided as follows:

I. Histoire naturelle: Astronomie, Géologie, Géographie physique, Météorologie, Pétrographie, Minéralogie, Phytologie, Zoologie, etc.
II. Histoire humaine: Histoire proprement dite, et Philologie; Histoire politique, sociale, morale, juridique, religieuse, linguistique, littéraire, artistique, etc.

These sciences, he supposed, reply to the question, what is real? Some of them, being correlated to certain sciences of laws, are indeed the descriptive counterparts of those theoretical sciences.

His third main division, "Canonique, sciences des possibilités dont la réalisation serait bonne, ou Sciences des règles idéales d'action", he subdivided into three classes:

I. Théories des moyens ou des arts:
   (1) Arts du plaisir immédiat: (a) Jeux, (b) Arts de la sensation, (c) Arts de la contemplation (beaux arts);
   (2) Arts du plaisir médiat ou de l'utile: Industries, cultures, Médicine, Politique, etc.;
   (3) Arts de la connaissance: Logique, Didactique;
II. Sciences morales ou théories de la combinaison des moyens;
III. Morale, ou théorie des buts obligatoires.

These sciences of rules of action answer in any choice of possible actions to the question, what is good? In addition to all the foregoing Naville recognized the sciences, or arts, of life and the fields of transcendental speculation. This is the nearest he comes to metaphysics, to philosophy, and to theology.

This interesting classification again exemplifies how a philosophic notion may induce a fallacious or inappropriate division, in this case worse than Spencer's or Giddings'. Laws, facts, rules,

these are indeed distinct, but to divide the sciences on such distinctions is absurd, for all sciences deal with laws and facts and rules.[9] What was presented here again was in new guise the time-worn distinction between *descriptive* and *historical data, theoretical* statement, and *practical, applied,* and *normative* science. Virtually Naville's system was largely a cross-classification somewhat similar to Bain's and to Masaryk's, and impaired by similar confusions. For instance, having placed Logic, most abstract of sciences, under the Arts of Knowing, he comprised there not only what is called Method, but also the theory and criticism of knowledge, a most abstract branch of philosophy.[10] Æsthetics he subsumed under *Sciences morales.* Under his *Arts psychiques* he grouped Politics, Government, Oratory, etc. In these diverse studies he recognized, however, that there are theoretical or abstract portions; for the first of his Sciences of Rules is Theory of the Arts. And to Astronomy, a branch of Natural History, he attributed the method of generalization and abstraction as especially relevant. Linguistics appeared first under his Theoretical, then under his Historical main division. There would be many other similar recurrences, if the scheme were worked out to a system.

2. CONCEPTUAL, PSYCHOLOGICAL, AND SUBJECTIVE SYSTEMS.

The recognition and rise of Psychology as a fundamental science supervened. The relation of Psychology to the psychological view of the order of the sciences is considered. Subjective systems are distinguished from objective and from psychological systems. The ideological systems of Rosmini and Destutt de Tracy are noticed, and Whewell's system of fundamental ideas is criticised. The Italian Baconian systems, and other triadic systems, conceptual or subjective, are mentioned, and La Grasserie's mélange. Janet's divisions objective (natural sciences) and subjective (mental sciences) are considered.

Psychology had not been recognized by Comte as a fundamental science; but by Ampère it had been made the first of his Philosophical Sciences. Spencer ranked the science of mind, not as a branch of Philosophy, but as a fundamental science. Bain and other successors of Spencer confirmed this position. This was the epoch of the rise of Psychology. Subsequently this crescent science extended its scope to almost half of the circle of studies, contributing methods and principles to their rapid development and manifesting its increasing importance to human life. The Psychological, or

[9] *Cf.* Stumpf, *Op. cit.*, p. 87.

[10] *Op. cit.*, p. 166.

Mental, Sciences have now supplanted the noölogical branch of Ampère's bifurcation and the Pneumatology of Bentham. For many synthetists this branch has come to comprise not only the sciences of mind especially but of all the products of mind, or even all the sciences of humanity, since mind is the characteristic of man. Sociology is treated as chiefly dependent on Psychology, and the Social Sciences are thus subordinated to the Psychological Sciences. But all the sciences may be arranged from the psychological point of view. This becomes the more likely when the several sciences are regarded as centered about dominant concepts rather than about objective data or contents or fields of study. This is sometimes distinguished as the "subjective view", and the systems are called *subjective.*

The Italian philosopher, Rosmini, in 1830 propounded the *ideological* origin of all sciences and affirmed that this is the basic principle of their order. Ideology he regarded as the only *pure* science; all the others he called *applied.* Being, he held, is of three modes, *ideal, real,* and *moral;* and correlative to these are the three modes of intelligence: *intuition, perception,* and *reason;* and to these his three-fold classification: (1) Sciences of Intuition, comprising Ideology and Logic; (2) Sciences of Perception, comprising Psychology and Cosmology; (3) Sciences of Reasoning, divided into Ontological and Deontological. The Deontological are those that treat of the perception of Being, comprising the Moral, the Æsthetic, the Political, the Economic, and Pedagogics. In this scheme the Physical and Mathematical sciences have scant recognition. We will refrain from further comment.

The famous French philosopher, Destutt de Tracy, in the beginning of the nineteenth century had published a similar system based on Ideology as its fundamental. This was divided into three: Ideology (in the stricter sense), comprising Grammar and Logic; sciences referred to the will, especially Political Economy, Morals, and Jurisprudence; and those that deal with natural objects, Physics, Geometry, and

Arithmetic. Æsthetics, Theology, and History were omitted. This clearly recalls the Stoic triad in the order: Logic, Ethics, Physics.

Whewell in 1840 in his *Philosophy of the Inductive Sciences* devoted a chapter to the classification of the sciences. The scheme he then put forth was limited by the scope of his work, the *inductive* sciences, but would have more significance "when we can include in it the moral, political, and metaphysical, as well as the physical portions of our knowledge." [11] This classification, he explained, "depends neither upon the faculties of the mind to which the separate parts of our knowledge owe their origin, nor upon the objects which each science contemplates;" (referring evidently to the basic principles of Bacon's system and of Campanella's — and of their successors) "but upon a more natural and fundamental element, — namely the *Ideas* which each science involves. The Ideas regulate and connect the facts, and are the foundations of the reasoning, in each science: . . . ." He gave a table of three columns, first "Fundamental Ideas or Conceptions", second "Sciences" named opposite their corresponding Ideas, and third "Classification" of classes into which he grouped them. ". . . . each Science may involve, not only the Ideas or Conceptions which are placed opposite to it in the list, but also all which precede it." This bears some resemblance to Comte's successive *filiation,* and it anticipated Spencer's order of gradation in increasing generality.

The essential ideas on which Whewell hung out his order of the sciences were mainly as follows: Space for Geometry, Number for Arithmetic, Sign for Algebra (sic), Limit for Differential Calculus, Motion for Kinematics and Celestial Mechanics, Matter for Statics, Inertia for Dynamics, Polarity for Electricity, Substance for Chemistry, Symmetry for Crystallography, Likeness for Systematic Mineralogy, Botany, and Zoölogy, Organization for Biology, Instinct, Emotion, and Thought for Psychology, Historical Causation for

[11] This and the following quotation are taken from the first edition (1840), Part II, Book XI, Chapter 9, pp. 277-82. The third edition was changed extensively. Part II was rewritten under the title *Novum Organon Renovatum* (1858), but this chapter was altered very little and the classification not at all.

Geology, Distribution of Plants and Animals for Ethnography, and First Cause for Natural Theology. This does not show all of these remarkable misappropriations of ideas (such as that of Sign to Algebra and Symmetry to Crystallography), but it suffices to display the absurdity of the undertaking. Nor was the resulting order of sciences a happy one. Geology, for instance, may have historical causation in it, but it does not companion with Psychology and Ethnography. The classes in the third column, however, were not so bad; but in so far as the terms used there implied definition, they were not at all appropriate; for example, Chemistry was termed the analytical science, but there are other analytical sciences — many of them.

Whewell's principle is admissible in so far as the several sciences develop about central ideas and interests, but these should not be mistaken for the whole scope or content of the sciences. Thus, when we say that Psychology is the science of mind, we mean not the *concept* of mind but all mental phenomena studied in the interest of human nature and mentality. By Physics we mean not the science of the *concept* of energy but of all the actions of energy. Then Space is not confined to Geometry, but is essential to Mechanics also, and to Astronomy. Again the idea of number is not confined to Arithmetic but is extended to Algebra; the theory of numbers is algebraic. But enough of this. The scheme will not work.

The systems of Bacon, Kant, Hegel, and others have been regarded as partly or wholly *subjective* (as distinguished from *objective* systems); they are not, however, to be regarded as psychological either in viewpoint, departure, or scope.

Basic division according to a Baconian triad of mental "faculties", but sometimes more like the Aristotelian, or the Stoic, and sometimes quite original, was among the Italian system-makers a predilection that became almost traditional.

Vico in the eighteenth century [12] anticipated Comte in ex-

[12] It is an interesting coincidence that the dates of Vico's birth and death are the same as those of the English poet, Pope, 1688 and 1744.

pounding the doctrine that social development is dependent on the progressive development of knowledge and that there have been three correlative historical stages in sciences, in arts, and in social institutions. These he named the Divine, the Heroic, and the Human. Tho they presented analogies to Comte's three stages, the theological, the metaphysical, and the positive, they were less true than his.

Janelli in 1817 came nearer to a psychological triad in distinguishing three stages of *sense,* of *imagination,* and of *reason,* which resemble Bacon's; for the descriptive sciences may just as well be deemed sciences of *sense* as sciences of *memory.* A classification professedly based on Bacon's was that of Valdarnini, who moreover defended his prototype — in 1870. Lablanca's system, published in 1875, was based on a similar mental triad, *reason, sense,* and *testimony,* to which correspond the *speculative,* the *experimental,* and the *documental.* This last division comprised the historical, linguistic, geographical, statistical, and economic. This triad is interesting as approaching the tripartite division, Philosophy, Natural Science, and History, which we have found valid in cross-classification. It also recalls the Stoic triad, if for Ethics we put Human History. Cantoni had a few years before outlined a similar scheme, involving cross-classification. His primary division distinguished the *rational* from the *experimental;* and across these he defined three classes: (1) those which treat of the principles and conditions of existence, Ontology, Natural Theology, and Cosmology; (2) those which treat of *material* things and conditions, Physics, Chemistry, Natural History, and Mathematics; and (3) those which treat of the human, mental, and spiritual, Psychology, Logic, Ethics, Æsthetics, Pedagogy, Philosophy of Law and of History.[13] This is objective rather than subjective. It may also be regarded as an extension of the Stoic triad, Logic there having been supplanted by Ontology and the Philosophy of Nature.

Conti's triadic system of *science, history, art,* set forth in 1876, was closer to Bacon's. In Science (in the broadest sense) he included Philosophy, Mathematics, Physical Science, and Positive Theology. Philosophy he divided into Speculative and Practical, the former branch comprising Ontology, Rational Theology, Cosmology, and Psychology, the latter branch comprising Logic, Ethics, and Æsthetics. This is better than Bacon's own. The Social Sciences, however, were not properly provided for.

[13] These statements rest mainly on Flint's paragraphs on this group of Italian systematists, *Op. cit.,* pp. 244–50 and 253.

In Corleo's system, published in 1880, the salient feature was Natural Science, placed first in the triadic basic division, Physical, Metaphysical, and Moral.

These systems were only in part psychological or subjective in view. They interest us chiefly as attempts to merge the fallacious triads of Aristotle and Bacon with the true triad of the Stoics, and to adapt the results to modern science. At the best, aside from their untenable basic divisions, they failed to correlate the sciences and the arts; nor did they comprehend the relation of the psychological, the social, the historical, the ethical, and the religious to the human and the natural thru anthropology, as is characteristic of the naturalistic view. The prevalent American classification for libraries by Melvil Dewey was constructed in 1876 of cognate materials, having been partly influenced by the system of Bacon and by that of the Italian, Battezzati (1871).

The subject-object relation is the rock on which several systems have gone to wreck. The objective aspect of nature should indeed be distinguished from the subjective aspect of natural science, tho they may present similar series of sciences. The mental, psychological, or human, sciences compose in a bifurcated system a branch coördinate with the natural sciences, or in a serial classification a series comparable to those sciences in extent and importance. Being chiefly descriptive, historical, and comparative, they are objective in point of view and are necessarily so studied. But, as mental science, they also have subjective aspects, and hence some thinkers have undertaken to classify them accordingly. As was said in the sub-chapter on "The Point of View", a series of sciences validly proceeding from the psychological or epistemological view may differ considerably from that resulting from the naturalistic view and may even subordinate the natural sciences to the mental sciences; and that may be done consistently with the purposes in view. But when the points of view are confused so inconsistently, many difficulties ensue. The subjective view of nature may

become grotesquely entangled with the objective view of mental phenomena.

Pamphilis in 1829 brought out a curious mixture of objective cause and subjective cause acting on each other and originating knowledge by "the reciprocal circular influence between nature and man". This was the basis for a triple division of the sciences into: (1) Objective, or *Not-Me,* (2) Subjective, or *Me,* and (3) Objective-subjective and Subjective-objective sciences, those of the *Me,* or *Ego,* in relation to the *Not-Me,* and of the *Not-Me* in relation to the *Me.*[14] The sciences can, we perceive, be brought under these philosophic terms: Linguistics, for example, may be regarded as a *me-re-not-me* science, and Economics as a *not-me-re-me* science, — or *vice-versa.* But we refrain from further dalliance with this bewitching terminology.

The subjective and the objective were combined together with the abstract and the concrete of Comte and Spencer, the pure and the applied of Bain and Goblot, and several other points of view and modes of study, in which the pedagogic and the æsthetic views were prominent, by M. Raoul de la Grasserie in what seems the most intricate and confusing of all the systems the writer has examined.[15] This remarkable system comprised an elaborate classification of the Arts and the Sciences, Concrete, Abstract-concrete, and Abstract (reversing Spencer's order). The sciences were divided into three classes: (1) those treating of objects, (2) those regarding distribution in time, (3) those regarding distribution in space. The first was divided into three *categories,* Pure, Gymnastic (educational), and Applied. By a series of six successive divisions of Pure science was reached the first science to be named, Astronomy, which according to the terms and definitions involved was the *simple, special, concrete, general, objective, pure science of those treating objects.* Let us fly from these bewildering mazes, which would baffle representation in a table of the *n*th dimension.

Paul Janet, an eminent French professor of philosophy, published in 1897 a series of lectures treating historically, critically, and constructively of the relations of the sciences and branches of philosophy to one another, and of their classification. Constructively he based his system upon the opposition of the *objective* and the *subjective,* primarily dividing the Sciences of Nature from the Sciences of the Mental, or of Humanity, in this following Ampère — and in some

[14] Flint, *Op. cit.,* p. 172.

[15] *De la Classification objective et subjective des arts, de la littérature et des sciences,* Paris, 1893, 304 pp.

other respects. Like Spencer, he argued against the feasibility of serial or linear classification.

"Donc, ni l'indépendence des sciences physiques et naturelles ne repose sur le matérialisme, ni l'existence indépendente des sciences psychologiques ne repose sur le spiritualisme; mais le double courant des unes et des autres repose sur le fait primitif de l'opposition du moi et du non-moi, du sujet et de l'objet. Ce qui est vrai, c'est que si, en un sens, le moi est conditionné par le non-moi, en un autre sens le non-moi est conditionné par le moi. De cette double et réciproque dépendence naît la nécessité de séparer les deux ordres de sciences, les sciences de la nature et les sciences de l'humanité, et par conséquent d'adopter la division binaire, et non la division linéaire." [16]

Avoiding Ampère's terminology, Janet divided the Sciences of Nature into the Inorganic and the Organic; then the inorganic he divided into the Mathematical, as abstract, and the Physical, as concrete. Physics he subdivided into Celestial and Terrestrial, thus agreeing with Comte, and further in placing Astronomy ahead of Physics. Terrestrial Physics he subdivided into Physics and Chemistry. This would be about the same as subordinating General Physics to Geophysics. The foregoing sciences are mostly abstract, he said, dealing with *laws and general conditions*.[17] Those dealing with *matter in existent forms* are on the other hand concrete. In the Physical Sciences there are two, Geology and Mineralogy. But he had said just before that the physical sciences in general are concrete as opposed to the abstract mathematical sciences. This, if taken literally, would show inconsistency worse than Spencer's or Bain's in the use of those misleading terms *abstract* and *concrete*.

Dichotomy, however, Janet did not carry to such extremes as did Ampère and Spencer. He indeed favored triplets. Thus the Mathematical branch has three branches, Arithmetic, Geometry, and Mechanics; and the Organic main branch, Biology, divided "en trois grandes sciences: *la biotomie, la biotaxie,* et *la bionomie*", terms that Comte adopted from the naturalist, Ducrotay de Blainville, and which are equivalent to our *morphology, taxonomy,* and *principles of physiology*. Botany and Zoölogy are the correlative concrete sciences.

"Passons aux sciences de l'humanité". Man is distinguished by mind, tho there is mentality in the other animals too; but by mind man subjectively distinguishes his own nature from that of nature external to him and objective. Yet human nature is related to physical nature and in such relations may be studied objectively.

[16] *Principes de Métaphysique et de Psychologie,* v. 1, p. 123.
[17] *Op. cit.,* pp. 124–5.

Herein Janet admits the justification of an unbroken series of sciences, despite his basic division.[18]

He went on to define three classes of sciences, the Historical, the Philological, and the Social. This placement of the Philological is one of the most interesting features of his system. He did not profess to construct a systematic and detailed classification, and it is indeed incomplete; but it is strange that in view of the title of his work he omitted Psychology, which he mentioned only incidentally in considering its relations to Physiology.[19]

In fine, Janet's argument for a basic division like Ampère's was not justified by the facts he adduced and the relations he considered; nor was there anything else in his classification that gave it any marked advantage over those of Ampère, Bain, Erdmann, and Masaryk.

3. THE CONGRESS OF ARTS AND SCIENCE.

Tho the Congress purposed a unification of science, Münsterberg's "Plan" for it resulted in many inconsistent separations. It was metaphysical rather than psychological. It was confusing and impractical, was disapproved, and contributed little to the solution of the problem.

Thru a perversion of psychological and metaphysical interest, a great opportunity was lost when The International Congress of Arts and Science at the St. Louis Exposition in 1904 was embarked on a program elaborated by a committee dominated by the brilliant psychologist, Münsterberg, who propounded the Scientific Plan of the Congress and prepared for it an impractical classification of the sciences. The main purpose of that congress was to display the "unity of human knowledge" and "the inner relation of the sciences of our day"; for ". . . the subdivision and multiplication of specialties in science has reached a stage at which investigators and scholars may derive both inspiration and profit from a general survey of the various fields of learning, planned with a view

[18] "De tous ces faits il résulte que la science de l'homme, même de l'homme intellectuel et moral, dépend des conditions étudiées par les sciences antérieures. . . . Voila donc les raisons qui militent en faveur de la théorie linéaire." — *Op. cit.*, v. 1, p. 120.

[19] Indeed this lecture (VII), and the preceding one, in a series to La Faculté de Paris, seem almost offhand, seven errors in terms appearing in those few pages.

of bringing the scattered sciences into closer mutual relations. The central purpose is the unification of knowledge," . . . This meant no mere partition of subjects or division of labor in research, no haphazard arrangement of topics and speakers, rooms and hours, but it meant relation and correlation, coördination and subordination, principles and consistency.

In the name adopted for the Congress the term Science appeared in the singular number and Arts in the plural. But the primary division distinguished Theoretical Sciences from Practical Sciences. The latter Professor Münsterberg distinguished from Applied Sciences and also from Arts as applying knowledge. "Almost every practical science can be shown in this way to apply a number of theoretical sciences; it synthesizes them to a new unity. But better, we ought to say, that it is a unity in itself from the start, and that it overlaps with a number of theoretical sciences." This would show close interrelation and indeed interdependence between theoretical and practical sciences, yet this plan *separated* all the theoretical sciences in four divisions from all the practical sciences in three divisions. All these *divisions* were subdivided into *departments*. As a result Technical Chemistry, for instance, is in Department 18 (Technology), while Inorganic Chemistry is in Department 10 (Chemistry). Another dependent relation was disrupted where Education (Dep't 23) was separated from Psychology (Dep't 15). And so of course it was thruout.

But it was in the division of the Theoretical Sciences that the psychologist most inconsistently subverted the unity which he had professed to maintain. Rejecting the naturalistic, the positivistic, and the pragmatist views, and adopting the empiricist, subjective, voluntaristic, and teleological, he advocated a new idealistic synthesis, and eloquently pleaded that reality and life are not merely a system of phenomena and relations, but of experiences, attitudes, actions, and purposes. He merged the subject and object in experience, discarding epistemological dualism.

"There cannot be anything more real than the immediate pure experience. . . . Our immediate experience does not contain an objective thing and a subjective picture of it, but they are com-

pletely one and the same experience." But inconsistently in the next paragraph he says: "We can abstract from all those reconstructions which the sciences suggest to us and go back to the most immediate naïve experience; but we can never reach an experience which does not contain the doubleness of subject and object, of will and world. That doubleness has nothing whatever to do with difference of physical and psychical; both the physical thing and the psychical idea are objects." — A confusion of subjective and objective views here makes the metaphysical basis seem abysmally vague and very difficult to comprehend or criticise.[20]

Having repudiated one dualism, he embraced another: ". . . . the object in its undifferentiated state on the one side and the subject in its will-attitude on the other side." In the next paragraph this became briefly "the object and the will-attitude. The two are one state; object and attitude form a unity. . . ." So this brings us back to monistic Fichtean idealism. But the following paragraph begins: "Our pure experience thus contains will-attitudes and objects of will; and the different attitudes of the will give the fundamental classes of human activity . . . . four different types of will-relation to the world. Our will *submits* itself to the world; our will *approves* the world as it is; our will *approves* the *changes* in the world; our will *transcends* the world. . . . Each of these four great types of will-attitude can be carried out on these three stages, that is, as *individual* act, as *historical* act, and as *over-individual* act." This last term seems to be equivalent to *universal,* or *general,* something essential to the community of subjects. "The system of knowledge is thus the system of experience with all that is involved in it in so far as it demands submission from our over-individual will, and the classification which we are seeking must be thus a division and subdivision of our over-individual submissions. We have thus four large groups of experiences to which we submit ourselves: over-individual will-acts, individual will-acts, over-individual objects, individual objects. They constitute the first four large divisions of our system."

Over-metaphysical this, is it not? And it was over-submissive on the part of the other members of the honorable Committee to allow the Professor to "put it over" on them. Professor Münsterberg then explained further, and his colleagues must have thought that he intended to fit his metaphysical basis to four well recognized structures of study: (1) Philosophy and Mathematics, (2) History, (3) Physi-

[20] The passages quoted here are taken from pp. 104–8 of vol. I of *The Proceedings of the International Congress of Arts and Science at St. Louis.*

cal Science, and (4) Psychological and Social Science; for they were arranged in four *theoretical* main classes as: (A) Normative Science, (B) Historical Science, (C) Physical Science, (D) Mental Science; and to these were added three *practical* main classes: (E) Utilitarian Sciences, (F) Social Regulation, and (G) Social Culture.

Each of these seven *divisions* was subdivided into *departments,* of which there were twenty-four, as follows:

Division A, Normative Science.

Dep't 1, Philosophy.

Section A, Metaphysics,
" B, Philosophy of Religion,
" C, Logic.
" D, Methodology of Science,
" E, Ethics,
" F, Æsthetics.

Dep't 2, Mathematics.

Division B, Historical Science.

Dep't 3, Political and Economic;
" 5, History of Language;
" 7, History of Art;

Dep't 4, History of Law;
" 6, History of Literature;
" 8, History of Religion.

Division C, Physical Science.

Dep't 9, Physics;
" 11, Astronomy;
" 13, Biology;

Dep't 10, Chemistry;
" 12, Sciences of the Earth;
" 14, Anthropology;

Section A, Somatology,
" B, Archeology,
" C, Ethnology.

Division D, Mental Science.

Dep't 15, Psychology;

Dep't 16, Sociology;

Division E, Utilitarian Science.

Dep't 17, Medicine;

Dep't 18, Technology;

Dep't 19, Economics.

Division F, Social Regulation.

Dep't 20, Politics;	Dep't 21, Jurisprudence; Dep't 22, Social Science.

Division G, Social Culture.

Dep't 23, Education;	Dep't 24, Religion.

These departments were further subdivided into *sections,* 128 in all. If space permitted us to give the entire table, many inconsistent and inconvenient separations could be pointed out as resulting from the fundamental divisions. A single instance must suffice: Mathematics is Dep't 2, Physics is Dep't 9, and Technology Dep't 18. The theoretical, the normative, the historical, the practical, the utilitarian, are terms that distinguish different types of studies, or of interests, and they may be valid for subdivision or for cross-classification, but they are not appropriate bases for the classification of the sciences.[21]

The scientists who contributed to this great movement for classification and synthesis themselves found fault with the system to which they had made their "over-individual" submissions without their individual approval. This was admitted by Professor Münsterberg himself.[22] But some of his critics were more positive. "The classification of the sciences of this Congress", said Professor Blackmar, Chairman of the Department of Sociology, "has done more to throw the subject into confusion than any other event of recent years. . . . No subjective classification arising from *a priori* assumptions, proceeding from a psychological source, will satisfy the demands of a working classification for science, which must of necessity arise from objective conditions." [23] There were, however, remarkably few allusions to, and a con-

[21] *Cf.* Becher, *Op. cit.*, pp. 9–10.

[22] "There was in some cases a fundamental attitude taken which did not harmonize with those logical principles which had led to the classification; for instance, we had sharply separated, for reasons fully stated above, the Division of History from the Division of Mental Sciences, including sociology; yet some papers for the Division of History clearly indicated sympathy with the traditional positivistic view, according to which history becomes simply a part of sociology. And similar variations of the general plan occur in almost every division." (*Loc. cit.*, p. 128).

[23] *The Proceedings,* v. 5, p. 786.

spicuous absence of commendation of Münsterberg's Plan — thruout the volumes of masterly, broad-minded papers read at the Congress. But the scientific and philosophic coherence of the contributions in large measure countervailed the confusing results of the inconsistent and perverse product of the psychologist's teleologic logic.[24]

[24] A very able criticism by Dr. E. C. Richardson, in the *Library Journal* of October, 1904, deftly touched upon certain aspects not covered in these paragraphs. The "Outline" shown in Richardson's book on *Classification* followed not the amended "Plan", but that proposed, which appeared on pp. 13–15 of vol. 1 of the *Proceedings*, and which was even more objectionable. The next words after it were: "The Programme was again thoroughly revised. . . ." The final programme appeared on pp. 47–9 of the same volume. It is this that Dr. Richardson should have followed. But in the criticisms just praised the Programme was reproduced properly from its final form.

CHAPTER XX

THE MOST VALID AND ADEQUATE MODERN SYSTEMS.

1. WUNDT'S GREAT FAILURE.

Thru fallacious fundamental divisions, which separated closely related subjects and even mutilated unitary sciences, Wundt, tho well qualified, failed in his prior system, which is better known than his later, more valid system.

Wilhelm WUNDT, the illustrious founder of modern psychology and master of the psychological sciences in their broadest development, deserves prominent recognition here for having produced a distinctive system for classifying knowledge that in some important respects is the most logical and the most complete. For mastery of this problem he was preëminently fitted by his comprehensive mind and his wide range of studies; and it is to be regretted that his success was not more positive. Wundt's interest, however, was originally logical and methodological, a division and subdivision of knowledge and method rather than a classification and synthesis of the sciences and arts.[1] Wundt's three tables it is worth while to translate, combine, and condense in the table given on the following two pages.[2]

[1] See his *Logik,* vol. II, *Methodenlehre.* First published in 1883, the work was enlarged in the second edition (1895), and was further elaborated in the third edition in three volumes (1906–8). His special essay, "Ueber die Eintheilung der Wissenschaften", appeared in his *Philosophische Studien,* Band 5 (1889), pp. 1–55. It is this system that is usually commended and it is to this that the following criticism chiefly applies. His more commendable system in the third edition of the *Logik* will be considered in the third section of this chapter.

[2] Prof. E. B. McGilvary's article on "Sciences, — Classification of", in *The New International Encyclopedia* (prior edition, of 1908), comprised elaborate tables of Hobbes' system, Spencer's, and Wundt's, carefully compiled, but for the last the terms were not well translated. The table adopted by Flint from Ladd's *Introduciion to Philosophy* was for the Philosophy only. It differs in not showing Philosophy of History as the last subdivision.

SYSTEM OF THE SCIENCES

A. Formal, or Mathematical, Sciences.

I. General.

a. Quantitative.
1. Algebra.
2. Theory of Functions.

b. Qualitative.
Theory of Manifolds, Assemblages, etc. (*Mannigfaltigkeitstheorie.*)

II. Special.

a. Number.
1. Arithmetic.
2. Theory of Numbers.

b. Space.
1. Synthetic Geometry.
2. Analytic Geometry.

c. Motions. Kinematics.
1. Synthetic
2. Analytic.

B. Real, or Empirical, Sciences (*Erfahrungswissenschaften*).

I. Natural Sciences.

A. Sciences of the Processes of Nature (Naturvorgängen).

I. General: Dynamics.

a. Of Masses.
1. Of Bodies.
2. Of Molecules.

b. Of the Æther.
1. Ætherdynamics, General.
2. Relations of Æther to Radiation.

II. Special:

a. Physics.

b. Chemistry.

B. Sciences of Natural Objects (Naturgegenständen).

1. Astronomy.
2. Geography (*Lehre von der Erde*).
3. Special Terrestrial Objects:
   a. Natural History: Mineralogy, Botany, Zoölogy.
   b. Special Geography.

C. Sciences of Natural Processes in Natural Objects.

I. Concrete Physics and Chemistry:

1. Astrophysics.
2. Geophysics.
3. Minerals.
4. Physiology, etc.

II. History of Development, Evolution, Cosmology, Geology.

II. Mental, or Psychological, Sciences (*Geisteswissenschaften*).

A. Sciences of Mental Processes (von den geistigen Vorgängen).

I. Psychology, General, Individual, and Comparative.

II. Special Psychology of:

a. Animals, and Peoples (*Völkerpsychologie*).
b. Bodily Processes:
1. Psychophysics,
2. Anthropology and Ethnology.

B. Sciences of Mental Products (Geisteserzeugnissen).

I. Philology.

II. Political Economy, Politics, Jurisprudence, Theology, the Arts.

C. Sciences of the Development of Mental Products, Historical Sciences.

I. History.

II. Special History: Economic, Political, Law, Religion, Arts, Sciences.

SYSTEM OF PHILOSOPHY

A. Philosophy of Knowledge (*Erkenntnisslehre*).

I. Formal Logic.
II. Real Doctrine of Knowledge (Epistemology).
a. Development of Knowledge and History of Science;
b. Theory of Knowledge, and Methodology.

B. Philosophy of Principles (*Principienlehre*).

I. General Principles, Metaphysics.
II. Special Philosophy.
a. Philosophy of Nature (Cosmology) and of Life;
b. Philosophy of Mind, Ethics, Law, Religion, Art, History, etc.

Tho he affirmed the unity of knowledge and the relativity of views, Wundt then attempted by several rational divisions to embody in one system the most important general modes of regarding the objects of knowledge in their manifold relations: the empirical, the analytical, the historical, the developmental, the synthetic, and the philosophical. But these modes, tho indeed significant in the system of knowledge, are not proper basic divisions for the classification of the sciences.

Wundt's primary division of Philosophy *and its branches* from the Sciences separated all the special philosophy of science, of art, of religion, of history, etc. from the cognate and correlated sciences. It is as if he tried to separate the fields of knowledge from the fields of thought. But philosophic thought should rest on scientific knowledge. The philosophic studies of certain aspects of nature, and of certain mental and social products are indeed to be classified as branches of philosophy: philosophic cosmology, abstract theology, philosophic psychology, ethics, and æsthetics; but on the other hand the philosophy of mathematics, of biology, of history, of economics, of law, of education, and of many other special sciences or studies belongs rather under those specialties. As we have said before, cross-classification avails for these relations. Philosophy is indeed distinct, and

certain of its branches may be regarded as paralleling the correlative sciences; but the division and separation should not be so basic and exclusive as in Wundt's system.

That the sciences are to be classified not by their methods — not especially by the method of abstraction — but by their contents, characters, and purposes, was a point that Wundt repeatedly emphasized.

"Bei dieser Unerlässlichkeit des Abstractionsverfahrens zu jeder Art wissenschaftlicher Forschung und Begriffsbildung ist es völlig unmöglich, dem Grade der Abstraction einen sicheren Maſsstab für die Gliederung der einzelnen Gebiete zu entnehmen." — *Ueber die Eintheilung der Wissenschaften,* p. 19. On the next page he distinguished the Mathematical sciences not as *abstract* but as *formal:* "In Wahrheit beruht aber der Unterschied der mathematischen und der empirischen Wissenschaften überall darauf, das sich jene nicht auf die Gegenstände und Vorgänge der Natur selbst, sondern auf die *formalen Abstractionen* beziehen, zu denen ein beliebiger Erfahrungsinhalt Anlass geben kann. Nicht in der Thatsache der Abstraction oder auch nur in dem Grade derselben, sondern in ihrem *formalen* Charakter besteht daher die wesentliche Eigenthümlichkeit der Mathematik." [3]

Wundt furthermore not only distinguished the statical and morphological from the dynamical and functional but he separated these implicated and correlated branches in the several natural sciences; that is, he separated (A) the Sciences of Natural Processes from (B) the Sciences of Natural Objects, and (C) the Sciences of Natural Processes in Natural Objects. The classes so termed are, however, about the same as the Abstract and theoretical, the Concrete and descriptive, and the Abstract-concrete, which he had emphatically repudiated, and they are open to the same objection. Moreover, in the third class (C) he separated the historical studies from the descriptive and theoretical. So Chemistry would have its theoretical studies in Class A, while the Physics and Chemistry of Minerals would be in Class C and Descriptive and Systematic Mineralogy would be apart in Class B. Thus too, Astronomy, a science of natural *objects,* would be separated from Astrophysics, the descriptive and theoretical study of physical and chemical *processes* in astronomic objects, and again from the *historical* and evolutionary *processes* theorized in Cosmology and in Geology. But how can such separations be maintained? All these sciences are distinct studies at once descriptive of a field of natural objects and theoretic regarding the natural processes involved. In this system Geography in the widest sense ranked beside Astronomy, and Geo-

[3] *Cf.* Becher, *Op. cit.,* pp. 9–10.

logy was subaltern first to Geography, second to Astrophysics, and third to Cosmology, and thus was dismembered in the three divisions A, B, and C. So the descriptive and systematic studies of Botany and Zoölogy were separated from the descriptive and theoretical studies of organic processes, that is, from Biology and Physiology, which were placed in the third class (C); and both these implicated branches were furthermore separated from the history and evolution of organisms (in the second subdivision of Class C), that is, the biology and morphology from the Phylogeny.

In the Mental Sciences, the main division coördinate with the Natural Sciences, Wundt perpetrated analogous dismemberments: (A) the Sciences of Mental Processes, (B) the Sciences of Mental Products, and (C) Sciences of the Development of Mental Products. This last comprised (I) General History, (II) Special historical studies, or humanities, and histories of the peoples, of their mental products, their institutions, sciences, and arts. Economic History, as well as the History of Economics, this system thus separated from the psychological and ethnological studies of the *mental processes* (A) underlying them, and from the Social Sciences and Arts as *mental products* (B) that are so closely interwoven with those studies. In these fields how can we discriminate which studies are of processes and which are of products? Do not the arts involve processes as well as products? Can the study of art be dissevered from the history of art? Can the theory of pedagogics be severed from the philosophy of education and from its history?

The truth is that the philosophic, the historical, the abstract, the analytic, the synthetic, the descriptive, the theoretical, are all but modes or methods of regarding or treating the data of knowledge, or the sciences, and, as we have said several times before, they may be represented by cross-classification, but they are not appropriate for basic divisions.

This earlier system of Wundt's conformed neither to the order of nature nor to the natural order of the sciences. Its divisions resulted in many inconvenient separations of studies that are closely related, and it dismembered too many sciences that have long been unitary. It was therefore invalid for the partition of studies and inadequate for the functional organization of knowledge. We are fully justified in pronouncing it a great failure.

2. THREE LESSER FAILURES.

Bordeau supposed that the special sciences are distinguished by general methods. Hoffman divided Normative Sciences from Empirical Sciences. Barthel more recently invalidated his system by faulty divisions.

M. L. Bordeau, a follower of Comte, advocating a series of fundamental sciences, chose the invalid criterion of *method* as the basis of definition and division.[4] To seven sciences he gave Greek names, defined them with single terms, and supposed them dependent on distinctive, predominant methods, as follows: Logic he named Positive Ontology, defined as "science of realities", its distinctive method being *intuition* (sic); Mathematics, named Metrology (sic), the science of magnitudes, its method *deduction;* Dynamics, yclept Theseology, the science of positions (sic), observation its method; Physics, alias Poiology, the science of modalities (?), its own method experimentation; Chemistry, masquerading as Craseology, the science of combinations, its method integration (!); Morphology, still Morphology, the science of forms, its method comparison; and Physiology, termed Praxeology, studying functions, by connection (?) (or correlation?) Psychology and Sociology he did not recognize as fundamental sciences. Untenable, inept, erratic, absurd, this system, which received some misleading praise in Flint's pages takes our "booby prize".[5]

The *Normative* Sciences were distinctively divided from the Empirical Sciences in a classification by Frank S. Hoffman.[6] The term *normative* had appeared before, for the ethical and practical sciences, which supply norms or rules for the conduct of life and thought. As other sciences do this besides those so designated, the term is not distinctive and the division is invalid, tho it may apply in a relative sense to

[4] *Théorie des sciences,* 2 vols., Paris, 1882.
[5] *Op. cit.,* pp. 254–5.
[6] *The Sphere of Science,* New York, 1898, chapter on the "Harmony of the Sciences".

sciences more especially purposed to produce norms. In the Programme of The Congress of Arts and Science the term *Normative Sciences* was employed for the Philosophical and the Mathematical Sciences, but not for other sciences practical, economic, social, or ethical.

A more recent system, interesting but faulty, which evidently leans on Wundt's improved system in his *Logik,* is that of E. Barthel, a German philosopher, propounding the philosophy of values.[7] He did not follow Wundt in opposing the Mental Sciences to the Natural Sciences and in subordinating them all to Psychology; but he made them the fourth division of the Natural Sciences, the other three being: I, the Inorganic, II, the Organic, and III, History. His main divisions were: (A) Theory of Knowledge, (B) Logic and Pure Mathematics, (C) Natural Sciences, and (D) Philosophy, which he subdivided into (1) Empirical Investigation of Values and their Objects, (2) Metaphysics, and (3) Culture Philosophy. The Mental Sciences, or Sciences of Humanity, he subdivided into: (1) Society, comprising Sociology, Law, and Religion; and (2) The Individual within Society, under which he subsumed Linguistics, and History of Literature, of Art, and of Thought.[8]

Barthel's system was impaired by faulty divisions; it widely separated Theory of Knowledge from Philosophy. In the Natural Sciences it divided History from the Sciences of Humanity, instead of treating it as crossing all these sciences. Geology was conspicuously misplaced in the division for the Organic. Theory of Matter was separately coördinated with Chemistry and Physics. Biology was subordinate to, instead of being coextensive with the science of the Organic. Because of these and other faults and inconsistencies, this system must be pronounced another failure.

[7] *Zur Systematik der Wissenschaften,* in *Archiv für systematische Philosophie,* Bd. 16 (1910), pp. 498–520.

[8] This classification was not accurately represented by the table in Richardson's book.

3. SOME ALMOSTERS.

A few have almost succeeded. Shields, a philosopher, outlined an almost correct scheme grounded on valid principles. Richardson, the librarian, made a classification as correct, and more complete. Wundt's improved system was on the whole as nearly right as it is consistent, but it was not faultless. Ostwald projected a system in a mere outline, in which — so far — there was nothing radically wrong. Becher contributed a methodological analysis and a valid argument. Stumpf had preceded him in this way. The American Association for the Advancement of Science arranges its sections in nearly correct order.

An amateur mountaineer once wrote to a friend describing an ascent. A few of the climbers, including some ladies, had enough of the mountain before the top was attained and decided to sit and enjoy their own views and reflections, while the others went on to achieve the summit. They had *almost* reached the top anyhow, they said. The *almosters* the mountaineer termed them.

The classification of the sciences has proved to be a peculiarly baffling problem of mountainous magnitude and of many points of view. Many thinkers have supposed, from their several viewpoints, that they had surmounted the problem; yet none had quite succeeded according to the consensus of scientists and philosophers regarding the order of nature and the developing interrelations of the sciences. Indeed only a few seem to be entitled to be named as *almosters*.

Bacon and Hobbes, Kant and Hegel, D'Alembert and Ampère, Bentham and Whewell, Comte and Spencer, Bain and Pearson, Erdmann and Masaryk, Giddings and Janet, Goblot and Naville, all these minds of high ability, and others unnamed here, failed to master this problem even for their period. It remains for us now to consider a few who have *almost* mastered it. We will take them in chronological order.

Charles Woodruff Shields, a philosophical and theological writer well known in his day, published in 1882 *The Order of the Sciences, an essay on the philosophical classification and organization of human knowledge.*[9] That remarkable essay

[9] This was incorporated into Shields's *magnum opus*, entitled *Philosophia Ultima*. The kernel of this work appeared in 1861. This was recast under

deserves continued recognition for its broad scientific view, its incisive criticism, its valid arguments, and its constructive contribution, which in important respects was, as merely outlined, more nearly correct than any preceding system.

Assuming the objective, naturalistic view, Shields distinguished "classes of facts" and fields of knowledge and groups of sciences. On six of these fields he grounded the six *Principal* sciences: Physics, Chemistry, Biology, Psychology, Sociology, and Theology, the first three distinguished as Physical sciences from the last three as Mental, or Psychical, sciences. For each principal science he indicated an empirical and a metaphysical branch, except that to Biology he ascribed three, Biology proper (or Physiology), Botany, and Zoölogy. The principal sciences were also regarded as *fundamental* to groups of *derivative* or concrete sciences or studies. As examples of these he named Astronomy, Geology, and Anthropology. He did not expressly include Economics, Law, Education, Philology, Ethics, and Æsthetics. Logic and Mathematics he set aside as "disciplinal studies", which may be applied to "the content of positive knowledge, when they simply become parts and processes of other more real sciences." This too brief notice may well commend the author's own admirable survey.

Ernest Cushing RICHARDSON, whose book on *Classification* we have cited many times, outlined therein [10] a philosophical classification in serial form under four main divisions, which is as nearly correct as that of Shields, while it is more complete. He too deemed Theology one of the principal sciences and made it the culminating main division. For his first main division, the Mathematical and Physical sciences, he introduced the term Hylology (from the Greek ὕλη, wood),

the title *Final Philosophy*, issued in 1877 and revised in 1879. The third edition, 1888–9, was enlarged in two volumes with the long title: *Philosophia Ultima, or Science of the Sciences, an historical and critical introduction to the final philosophy as issuing from the harmony of science and religion.* It is this work that we have cited several times.

[10] See the second edition (1912), pp. 19–22 and the Table on p. 85. The first edition was published in 1901.

an olden term for the science of unorganized matter. His second main division was Biology, and his third Anthropology. This last is distinctive and creditable. Philosophy was not named in Richardson's tables, but two of its branches were subordinated, Cosmology under Theology and Epistemology under Psychology, which was placed under the Anthropological Sciences. We should bear in mind, however, that Philosophy is regarded as a comprehensive study, to be superposed on all. Logic too did not appear in the tables, but was probably subsumed under Epistemology. The affiliation of Mathematics with the Physical Sciences was formerly not unusual, but now this general method is found applicable to a wider range of sciences. More objectionable is the separation of Sociology from Psychology at the extreme ends of the Anthropological Sciences, with Æsthetics, the Arts, and Language and Literature intervening. Wundt too did something like this. It not only interposes Language and the literatures between the most closely related psychological sciences, but it separates Industrial Arts from Economics, which must be subsumed under Sociology. Yet these faults do not impair the system so positively but that it may be ranked as one of the almost satisfactory schemes.

Wundt in his professed essay to partition the sciences failed, as we have shown,[11] because of untenable and impractical divisions. But in his greater work on Logic he embodied a classification of knowledge in which he not only avoided those objectionable divisions [12] but laid down an almost correct series of fundamental sciences with consistent and nearly correct subdivisions. Nor was the order of this improved system inconsistent with that of the earlier system when disentangled from its invalid divisions. Here again Wundt emphasized the division of the Mental Sciences from the Natural Sciences, but that did not distort his series; for

[11] *Supra* pp. 384–5.

[12] See especially the third edition, Band 2, pp. 274–80, under the caption "Das System der Naturwissenschaften" and Band 3, pp. 1–23, "Das System der Geisteswissenschaften".

the special sciences of humanity that are termed ethonological, psychological, and social he subordinated to the Mental Sciences, and under these to Psychology, which he treated as the connecting link between the Mental and the Natural Sciences.[13] His special interest in *Völkerpsychologie* led him, however, to subordinate to it all the social sciences and history, Philology, *Sittengeschichte,* Ethology,[14] Mythology, and Art. These relations may better be shown by his table, which is condensed below.

I. Logic.

II. Mathematics.

III. Natural Sciences.
- I. Mechanics.
- II. Physics.
  - a. Cosmical.
    - 1. Astronomy, Descriptive and Celestial Mechanics.
    - 2. Astrophysics.
  - b. Geophysics: Geology and Geography.
- III. Chemistry.
- IV. Biology.
  - a. Anatomy.
  - b. Physiology.
  - c. Natural History.

IV. Mental Sciences (*Geisteswissenschaften*).
- V. Psychology.
  - a. Individual.
  - b. Social (*Völkerpsychologie*).
    - 1. Philology.
      - Linguistics.
      - Mythology.
      - Art.
      - Ethology and *Sittengeschichte.*
    - 2. History.
    - 3. Sociology.
      - Ethnology.
      - Population, Vital Statistics.
      - Social Economy.
      - Jurisprudence.

V. Philosophy.

[13] "Hier bedarf vielmehr die Biologie der *Psychologie* zu ihrer Ergänzung, mit der vereinigt sie das verbindende Glied ist zwischen den Natur-und den Geisteswissenschaften." — *Loc. cit.,* Band 2, p. 277.

[14] The term *Ethology* is to be distinguished from Ethnology. The former treats of the *Ethos,* the latter of the *Ethnos.* But it has been used otherwise by biologists, and we should avoid it, until its definition is established.

By placing Philology ahead of History and Sociology Wundt separated Sociology from Social Psychology, Ethnology from Ethnopsychology, and Mythology from both. For a functional organization of knowledge it would indeed be inconvenient to have these closely related studies separated by the immense fields of language, literature, and art. In the Natural Sciences, Mechanics should be subordinated to Physics rather than coördinated with that general science, as was formerly done by some mathematicians. And how can all the various arts be subsumed under Philology? The Useful Arts are more closely related to Economics.

Valuable to methodology and also to the organization of knowledge tho we must deem this later contribution of Wundt, we find in it grave faults that disqualify it from being credited with consummate achievement of the purpose.

Wilhelm Ostwald, a broad-minded scientist of the first rank tho perhaps not so broad as Wundt in philosophic attainments, was also interested in the classification of the sciences. From his important address on *The System of the Sciences* we have quoted elsewhere. In his little book on *Natural Philosophy* [15] a chapter is given to outlining a classification, which most of the book is occupied in amplifying, tho not in detail. "The basic thought", he said, "upon which this classification rests is that of graded abstraction. . . . So we shall begin the system of the sciences with the most general concepts, . . . and in grading the concept complexes according to their increasing diversity, set up a corresponding graded series of sciences." The tabular outline is reproduced on the next page.

In addition to these, or rather "side by side with the pure sciences are the *applied,* which are to be distinguished from the pure sciences by the fact that they do not unfold their problems systematically, but are assigned them by the external circumstances of man's life." This implies cross-classification at least for parts of the two parallel series. If

[15] The translation by Thomas Seltzer was published in 1910 in New York.

Ostwald had considered Philosophy too, he would have perceived that certain branches of philosophy parallel, or are correlative to, certain of the sciences.

I. Formal Sciences. *Main concept: Order.*
Logic, or the science of the Manifold.
Mathematics, or the science of Quantity.
Geometry, or the science of Space.
Phoronomy, or the science of Motion.

II. Physical Sciences. *Main concept: energy.*
Mechanics.
Physics.
Chemistry.

III. Biological Sciences. *Main concept: life.*
Physiology.
Psychology.
Sociology.

The fundamental pure sciences Ostwald thus regarded as successively dependent in order of gradation in generality. He commended Comte's conceptual "hierarchy", tho with strictures and modifications. His series is that of Spencer and Bain, but free from their untenable divisions, and without the "concrete" sciences, Astronomy and Geology. His own divisions are not inconsistent with his series but merely represent conceptual groups, or classes, of sciences. Classes of this kind there might indeed have been more of, one for the Psychological Sciences, another for the Social Sciences, and another for the Natural Sciences, or for the branches of the Philosophy of Nature, this last being especially consistent with the title of his book. In this way each fundamental science is the origin of a group of sciences,[16] which may be regarded as a division; and there is no inconsistency in this, if the divisions are properly subordinated in the serial order of dependence.

In distinguishing the several sciences by their central concepts Ostwald was, in view of what we have shown, on very questionable ground, tho his scheme, so far as it goes, is not impaired by that doctrine, as were Whewell's and Rosmini's. Definition by central concept may not be adequate, and other *differentia* may be requisite.

It is a matter of detail that in Ostwald's table the science of motion, which as Kinematics has long been domiciled under the physical science, Mechanics, was permitted to elope under disguise of the Kantian term, *Phoronomy,* with its conceptual affinity, Geometry, tho not debarred from a *formal* alliance.

[16] Compare Bain's Departmental Sciences (*supra,* p. 351), Masaryk's Fundamental Sciences (p. 356), Erdmann's Developmental series or groups (p. 359), and Shields' Principal Sciences (p. 389).

Here at last an eminent scientist and competent philosopher in handling this baffling problem has done nothing radically wrong. It represents not merely his view but that of the consensus of scientists and naturalistic philosophers. If he had worked out his system more completely, it would probably have been less faulty than Wundt's. As he did not, tho we may say that he *almost* succeeded, we cannot say that he achieved the *system* which he advocated for the future organization of science.

In contrast with Ostwald's scientific outline of the system of the sciences, the closely reasoned philosophic research of Professor Erich Becher distinguished broad classes, or groups, of sciences and studies and considered the relations of these rather than of the component individual sciences. A realist evidently, he treated the problem with special regard to the sciences of the real. There can be no science, he said, without order grounded in the order of nature; the reality and the order of the sciences correspond to and depend upon correlative order in nature.[17]

The sciences are to be divided primarily on grounds of their objective contents, and secondarily with respect to the aspects from which they may be regarded: (1) naturalistic, (2) historical, (3) epistemological. Several kinds of objective contents are considered as availing for the division: those of *first* and of *second order,* then the *abstract* as contrasted with the *concrete;* then *general, special,* and *individual* objects; next *things,* or *kinds* of things (*dingartige Objekte*) are contrasted with component objects (*seitenartige Objekte*) the parts, properties, organs, functions, and processes of natural objects or kinds — with their relations; then fundamentally *real* are opposed to *ideal* objects, and finally *physical* (*körperliche*) are contradistinguished from mental and spiritual (*seelischgeistige*) objects. Only the last distinction is valid and

[17] Becher, Erich. *Geisteswissenschaften und Naturwissenschaften: Untersuchungen zur Theorie und Einteilung der Realwissenschaften.* München, 1921, 335 pp. See especially p. 5. So much of a realist, or naturalist, is Becher that he regards as real, or objective, not only the objects or data of the natural sciences, but also those of history, of psychology, and of the sciences of culture. (pp. 19–20, 96–7, and 113–5). The order of the sciences depends on a correlative order in the several groups of objects related to the system of nature. (p. 5). Writing from the naturalistic viewpoint, Becher, however, concludes that the epistemological and subjective views are not inconsistent with that view but virtually reduce to it. (pp. 46–7, 54, and 75–6).

adequate for the basic division. Other principles and methods may enter secondary divisions, or cross them. The validity of Wundt's sciences of processes (*Vorgänge*) Becher denied.[18]

The sciences, with regard to their objective contents, their methods, and their epistemological grounds, are, according to Professor Becher, divided first into Sciences of the Ideal and Sciences of the Real. The former comprise Epistemology, Principles of Science, Logic, Methodology, Mathematics, and special branches of Philosophy. The Sciences of the Real divide into Natural Sciences and Mental Sciences (*Geisteswissenschaften*), and the former branch into the Physical and the Biological. In the Mental Sciences Becher includes not only Psychology but also the Social Sciences and the sciences of Culture, Philology, and the Arts. He is not explicit as to the order of these, and he says little about their relations in detail. He is intent — too intent — on his distinctions and divisions. The resemblance of these divisions to certain of Wundt's and Erdmann's is evident. But Becher judiciously avoided the chief errors of those philosophers. The order and system that are implicit in his argument would, if expressly outlined, prove to be consistent with the order we have found persistent in the scientific consensus. The importance of Becher's contribution lies chiefly in its carefully reasoned and valid argument in support of this order.

Of the several contributions cited by Becher that of Professor Carl Stumpf was in many respects most germane.[19] Stumpf's divisions, however, are not altogether similar; nor is his argument so elaborately developed; but his contribution compares with those of Becher, Wundt, and Erdmann.

Having considered the several principles of division, Stumpf concluded that none alone is adequate and that for the unitary system of science and philosophy the most feasible partition distinguishes the sciences by their objective

[18] *Op. cit.*, pp. 9–11 and 13–15.

[19] Stumpf, C., *Zur Einteilung der Wissenschaften.* In K. Preussische Akademie der Wissenschaften, *Abhandlungen der, Philosophische-Historische Classe,* V, pp. 4–94 (1906).

contents, the scope of their interests, and also their methods. But the divisions cross again and again; they may separate related sciences and may be inconsistent with other principles of division or other views of the system. Philosophy is not merely a unified general study, but a system of thought and of studies extending over the fields of many sciences and having branches correlative to certain parts of them.[20]

The several sciences are not concentric about a single generalization, the concentric circles being outwards more and more special, but they are rather, said Professor Stumpf in an illuminating analogy, like several systems of waves that expand outward from distinct centers and have manifold intersections.[21]

If there must be divisions, Professor Stumpf, recognizing the basic dualistic opposition of the physical and the psychical, would accept the division of the Natural Sciences from the Mental Sciences as the most valid fundamental division (p. 10). In the former branch he named, proceeding from the most general, first Physics and Chemistry, and in succession the sciences of minerals, of plants, and of animals, but without specifying the subordinate, or crossing, branches of these. In the Mental Sciences (*Geisteswissenschaften*), Psychology is the science of elementary psychical functions, and Political Science, Sociology, and the sciences of Language, of Religion, and of Art are sciences of complex psychical functions (p. 21). But he did not treat more particularly of the order or the relations of these several sciences to one another. He made it clear, however, that modern Psychology is so closely related to Physiology on the one hand and to Philosophy, Epistemology, and Logic on the other hand, that it must be regarded as intermediate between the Natural Sciences and the Mental Sciences. He then named as Neutral Sciences, which deal with objects neither physical nor psychical: (1) Phenomenology, (2) Eidology (*Eidologie,* die Wissenschaft der Gebilde), (3) Science of General Relations, including Epistemology, (4) Metaphysics. Subsequently he distinguished the studies of the Individual from those of the General, and those of the factual or actual from those of the theoretical and of "laws", also those of the homogeneous from those of the heterogeneous. Under these captions he considered certain relations of several of the special sciences.

[20] *Op. cit.*, pp. 86–7 and 90–1.

[21] "Die Gegenstände der Wissenschaften liegen nicht wie konzentrische Kreise um einen einzigen Mittelpunkt, sondern bilden meherer Wellensysteme, die von selbstständigen Mittelpunkten ausgehend sich schneiden." (*Loc. cit.*, p. 88).

The American Association for the Advancement of Science is organized in fifteen sections, representing distinct sciences and fields of study, and designated by letters A to Q. This order corresponds closely to the order of our Classification of Knowledge (p. 302 and in Table V, p. 235) and to that of the Main Classes of our Classification for Libraries (published elsewhere). This nearly complete agreement is set forth here in parallel columns.[22]

Sections of the A. A. A. S.	The Proposed System.
A. Mathematics.	A. Philosophy, General Science, Logic, and Mathematics.
B. Physics.	B. Physics.
C. Chemistry.	C. Chemistry.
D. Astronomy.	D. Astronomy, Geology, and Geography.
E. Geology and Geography.	E. Biology.
F. Zoölogical Sciences.	F. Botany.
G. Botanical Sciences.	G. Zoölogy.
H. Anthropology.	H. Anthropology, and Medical Sciences.
I. Psychology.	I. Psychology.
K. Social and Economic Science.	J. Education.
L. Historical and Philological Sciences.	K. Sociology and Ethnology.
M. Engineering.	L–O. History.
N. Medical Sciences.	P. Religion and Ethics.
O. Agriculture.	Q. Applied Social Science.
Q. Education.	R. Political Science.
	S. Jurisprudence.
	T. Economics.
	W. Philology, Linguistics, etc.

The Association has not as yet a distinctive section for the fundamental science of Biology, F being assigned to Zoölogical Sciences, which thus are separated from Anthropology in H by Botanical Sciences in G. Then the Medical Sciences in N are also separated from Anthropology, and Education in Section Q is separated from Psychology in I. If Education

[22] The scheme of the proposed system was outlined in 1903 and an outline was published in 1910. At that time the A. A. A. S. had but ten sections, A to K, Psychology being unrecognized, Astronomy not yet independent, and Education, History, Philology, and Agriculture not yet admitted. The order of the sections seemed incomplete and unsatisfactory.

were transferred to J and if Section F were designated Biology and Zoölogy, G being retained for the rather distinct science of Botany, or, still better, if Botany were transposed to F and Biology and Zoölogy to G, the resulting order would be a good step closer to the order of the scientific consensus. This would indeed, according to our view, be an important *advancement* in the *organisation* of science.

Originally a society of geologists and naturalists, the Association in the earlier decades of its growth was probably less interested in the order of the sciences than in their "advancement". Section F was a grouping of zoölogists, who were not yet calling themselves biologists; for biology then received much less recognition than now. The organization of the sections has been gradual in a historical setting. Psychology was not admitted to distinct sectionship until about 1920. For Education the eleventh section (L) was established about 1910. Agriculture was given section M about 1914. Astronomy was separated from Mathematics in A and assigned Section D about 1920, Engineering being transferred from D to M, and Agriculture from M to O. At the same time Medicine was transferred from K to N, and, to make place for Psychology in I, Social and Economic Science was transferred from I to K. About that time, too, the Historical and Philological Sciences were admitted to Section L, from which Education was moved to Q. Thus the four more general sciences are placed at the beginning of the series, four sections of applied sciences at the end, and the descriptive sciences, natural, human, and social, in between.

4. IS THE PROBLEM STILL PERSISTENT?

The classification of knowledge is a developmental product. The order of the sciences and studies that is maintained in the consensus of scientists, philosophers, and educators, is historically traceable from the triads of the Stoics and of Aristotle, thru the systems of Hobbes, Spencer, and Bain, to those to Erdmann, Shields, and Wundt, which we have found almost correct. The principle of *gradation by speciality* has emerged and is now combined with the principle of *collocation for maximal efficiency*, in the developed structural basis for functional organizations of knowledge.

The schemes we have briefly surveyed and criticised, whatever the purposes with which they were projected, have, with a few exceptions, been found unfit for the functional organization of science. Some pursued metaphysical ideas too far from the realities with which science is concerned; some have been entangled in subjective-objective confusions; and some

have split on the rocks of dichotomy. Those scientists and philosophers were — most of them — competent to synthesize the science of their time, and some of them were endowed with vision of the science of succeeding generations; but one after another they laid false foundations or laid hold of fallacious principles, whether borrowed from predecessors or invented for the purpose. Yet several of those system builders contributed truths of permanent value. On those foundations we who have followed have built, adopting the true and rejecting the false.

The classification of the sciences is not the work of any one mind, but, like science, is a developmental product. What is requisite now is a complete, adequate, and adaptable, system for the organization of knowledge. That will not be perfect; but it must be comparatively free from the errors we have criticised, and it must be relatively true to the relations and interrelations of the branches of study as they are conceived in the consensus of scientific minds. It will then be not only relatively true, but in its main features it will be relatively permanent.

The consensus was fairly well represented in the great Congress of Arts and Science, and it has been developed further since that historic gathering. It is very regrettable that the Plan of that Congress so inadequately represented the relations disclosed and clarified in the course of its discussions. We may say, however, that the order of nature was truly envisaged by those thinkers and that the order of the sciences was truly conceived by them.

This order of the sciences has been gradually developed thru the ages. The succession may be traced from the triadic division of the Stoics thru the *trivium* and *quadrivium* of the middle ages and the humanities of the *renaissance,* thru the remarkable system of Reisch at the end of the fifteenth century and the quadruple division of Descartes, who made Metaphysics coördinate with Physics; thru Bacon, who distinguished the empirical and historical from the rational;

thru Campanella, who objectified the several sciences; thru Hobbes, who first elaborated a system approaching the modern; thru Hegel's tripartite philosophy; thru the bifurcate systems of Bentham and Ampère; thru the series of Comte and Spencer; thru the cross-classifications that Arnott, Bain, Erdmann, Masaryk, and Naville combined with those series; thru the three-dimensional scheme of Stadler; — thru all these various systems the prevailing order may more or less clearly be traced to the nearly correct outline of the philosopher, Shields, and the nearly correct classification of the librarian, Richardson; to the nearly clarified outline of the philosophic scientist, Ostwald, and the nearly satisfactory logical system of the scientist-philosopher, Wundt.

Logic, Physics, and Ethics stand in the historic Greek background of the modern Philosophy of Knowledge, Philosophy of Nature, and Philosophy of Human Life; and also of Formal, or Abstract, Science, Natural Science, and Science of Humanity. In relation to these triads the *applied* sciences, the technologies, and the arts have their dependent places. Moreover, to the three terms of the Greek triad correspond three different types of views: (1) the subjective, and the epistemological, (2) the objective, or naturalistic, and (3) the ethical, and the humanistic. In Greek philosophy these three views were represented, tho hardly typified, by Plato, by Aristotle, and by Socrates. In modern thought those three antithetic views have persisted in the idealistic, the realistic, and the humanistic schools of philosophy; and these have maintained the three contrasted methods, the rational, the empirical, and the pragmatic.

If unitary knowledge be for some reason divided, the partition should be consistent with those real and natural distinctions and those fundamental logical divisions. In those divisions and their successive subdivisions there is implied, and from them there results, a serial order. And from the development that we have outlined has emerged the principle of *gradation by speciality*. This was the great contribution of

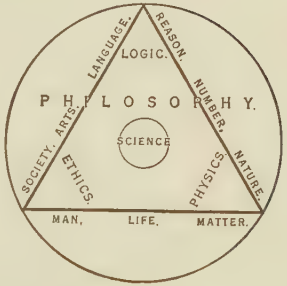
Comte. That serial order moreover proves to be nearly correlative to the order of historical development and dependence, and to that of pedagogical sequence. Structural classifications based on these principles and developed in consistency with these orders should therefore most adequately and adaptably serve the purposes of functional organizations of knowledge; and these principles combine with the principle of *collocation of related studies for maximal efficiency* in functional organizations of knowledge and especially in classifications for libraries.

EXPLANATORY NOTE

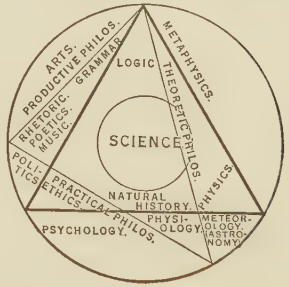
TO THE GEOMETRICAL FIGURES ON THE FOLLOWING TWO PAGES.

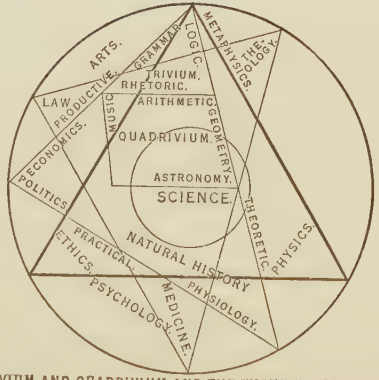
To represent the unitary system of knowledge we have drawn suggestive analogies, that of the tree, and that of the trellis of two-dimensional classification, also that of the circle, the encyclopædia of studies. The analogy of a helix, viewed from above, to a spiral, and of this to a set of concentric circles; and the analogy of a helix to a tree, viewed from the ground, were touched upon at the end of Chapter XII. Moreover, the divisions that we have termed *triadic* may be represented by triangles inscribed in concentric circles for Science, History, and Philosophy. In tripartite divisions the three subjects may be represented, as in our diagrams, either by the three angles of a triangle or by the three sides. Such analogies of course are not to be mistaken for realities. It is merely for their suggestive and objectifying values that we have attempted to visualize them in the accompanying geometrical diagrams. The central circles represent the scope of science as a unity; the outer circle stands for the comprehensive scope of philosophic thought; the intermediate circle for the scope of method and of history in the broad sense. Thus science, history, and philosophy are represented as unitary, expansive, and comprehensive, while the sciences and studies of Logic, Physics, and Ethics and the humanities, have divided and subdivided in manifold interrelations.

THE STOIC TRIAD

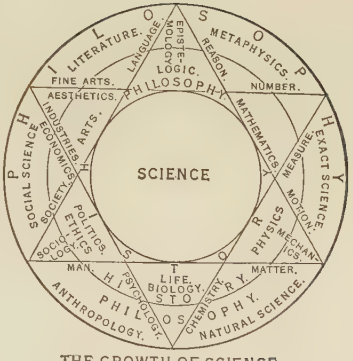


ARISTOTLE'S TRIAD
COMBINED WITH THAT OF THE STOICS.

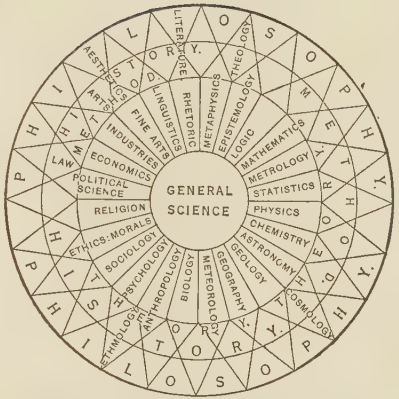




THE TRIVIUM AND QUADRIVIUM AND THE THREE FACULTIES OF THE
MEDIEVAL UNIVERSITIES, COMBINED WITH THE STOIC AND ARISTOTELIAN TRIADS.



THE GROWTH OF SCIENCE
IN RELATION TO
HISTORY AND
PHILOSOPHY.



AN ENCYCLOPEDIA
OF TWENTY-FOUR SCIENCES AND BRANCHES OF
HISTORY AND PHILOSOPHY

THE FUNDAMENTAL SCIENCES
AND RELATED BRANCHES OF
HISTORY AND PHILOSOPHY

En résumé, quoi qu'il en soit des diverses tendances qui se présentent dans les différentes parties de la Science, celle-ci se présente à nous comme une vue du monde extérieur à travers des concepts tirés par abstraction de l'expérience et rapprochés les uns des autres a façon à obtenir des lois qui rendent possible la coördination et la prévision. . . . Se rendant comte de la relativité de nos connaissances qui ne nous font connâitre que des rapports, les générations de savants avancent, au milieu de complexités toujours croissantes, dans leurs approximations successives; ils ont confiance dans le postulat de leur convergence, et espèrent trouver, au bout de ce labeur jamais terminé, une unité, déjà rêvée par les sages d'Ionie, dont la découverte sera peutêtre quelque jour l'honneur de l'esprit humain.

PICARD, *De la Méthode,* v. 1, p. 30.

CHAPTER XXI

SUMMARY AND CONCLUSION.

1. SURVEY OF THE PROBLEM AND THE PRINCIPLES INVOLVED.

We have surveyed a situation in which a need of paramount importance is evident and a wide-spread tendency to meet that need is manifest. The situation in its broadest aspect is a world situation, for the need and the tendency are world-wide — the need for more adequately organized knowledge and for more efficient coöperation in obtaining and applying it, and the tendency of groups and classes to organize and to coöperate for these great purposes. Human life should be socially organized on a basis of organized knowledge.

Societies are organized in the relations of their groups and classes, their communal ideals and interests, their cults and loyalties, their traditions and purposes, their pursuits and undertakings, their industries and occupations, their governments and institutions, their morals and laws; but these, whether viewed historically or rationally, are more or less erroneous and unsatisfactory; and this is largely because the social experience and knowledge inherent in them are not adequately organized. This applies not only to matters of common knowledge and of scientific, technical, and professional knowledge, but also to matters of economic, political, and ethical import, and even to those of intellectual, religious, and æsthetic interest.

This is not to say that man may live by knowledge and reason alone. The other side of his nature, the sensitive, the emotional, the affective, the imaginative, the religious, and the expressive, should all be nurtured and allowed to develop in intellectual and spiritual freedom, tho with proper restraints. The social organization should be plastic, adaptive, and progressive; it should not become too conservative in its institutions and too oppressive in its compulsions. Morals and precepts, sanctions and laws, principles and methods, should be maintained as relative and adaptive to conditions of social welfare and development. The individual within these social bonds and dispensations should realize at once a sane obligation and a secure freedom.

The term *organization,* like the term *organism,* implies a system of organs, or structures, and correlative functions. The entire structure is in a sense unitary, and it may function in a unitary or integrative mode; or it may otherwise function in parts only, without concomitant action in other parts. Structurally, however, an organization is a system of interrelated and interdependent parts.

Between the organization of an organism and the organization of society, as constituted of interrelated groups and classes, functioning in specialized and in communal interests, there are various analogies more or less valid. Some of these analogies extend to the organization of experience, knowledge, thought, and purpose in communal minds. This process, whatever its nature be, is presumably abstractive, synthetic, coherent, and coöperative. The manifold ideas, purposes, and activities, even while they differentiate and specialize in ever varying relations, in labyrinthine complexity, tend in other respects to cohere and to assimilate, to classify and to combine, to synthesize and to organize.

No rigid structure can function under such conditions; no inadaptable system can survive; an organism that no longer functions adaptively to changing conditions soon becomes a dead organization. The organization of society and likewise

the organization, structural and functional, of social knowledge must needs be plastic, adaptive, and progressive.

In the development of knowledge subjects logically divide and subdivide, proceeding from the more general to the more special. This is the logical process of specification, differentiation, *division,* and *analysis.* But, conversely, special subjects are dependent on the general subjects from which they are derivative — are *subordinate* to them. So knowledge and thought may bring the specific under the relevant general in the process of *synthesis* and organization.

Knowledge thus is both analytic and synthetic. In analysis we pass from the more general to the more special, from the more comprehensive to the more definite. In synthesis, the antithetic process, we pass from the more specific to the more general and comprehensive. A system of knowledge should function in both these ways; it should be both analytic and synthetic. The classified data of analytic knowledge are synthesized in the conceptual systems of knowledge and thought. Analysis is analogous to the branching of a tree. Synthesis is analogous to the confluence of streams in a widening valley, or to the unitary relation of twigs to branches and of the branches to the tree. In this analogy we are wont to validify the metaphor of *the tree of knowledge.*

In this analogy too, the structural organization of knowledge is three-dimensional. The divisions and subdivisions of the subjects of knowledge and thought may be regarded as branches and branchlets in the second and third dimensions of the structure. For certain purposes, however, the structures may be represented as two-dimensional — as schematic, or diagrammatic. The tree may be said to be trained to a trellis regarded as relatively two-dimensional. Classifications, and especially cross-classifications, are reducible to this analogy. The closely related subjects may be regarded as juxtaposed — coördinated and correlated — so far as the main branching allows. Less important relations may be

superposed in a reticulation of cross-references, to which the analogy of a vine is not inappropriate.

Successively subordinate subjects, or classes, may be regarded as a series of branches ascending from a unitary trunk. and with regard to that relation they may be termed coördinate. Such a series of coördinate terms may be treated as one-dimensional, or *serial.* But in another aspect the several coördinate subjects are seen to be successively subordinate, or *scalar,* because step by step in logical division they are more specific. Again the subsequent items in this scalar, or graded, series are dependent on the antecedent. On this ground rest the principles of *gradation by speciality* and *serial dependence.* These principles are virtually the same as those variously termed and stated by Comte, Spencer, Bain, Ostwald, and others, in relation to the order of the sciences.

The analogies entertained above should of course not be overworked. They serve, however, to vivify the valid logical principle of the *subordination of the specific to the generic,* upon which depend all systematic classifications and structural organizations of knowledge. In any functional organization of knowledge that principle may well be combined with the resultant principle of *maximal efficiency* thru *collocation,* or synthesis, of closely related subjects in the most important relevant interests. The prevalence of alphabetic and of dispersive analytic subdivision in the established systems of cataloging and classification for libraries, with the lack of this functional, synthetic organization we have termed "the subject-index illusion".

2. THE ORDER OF NATURE AND THE SYSTEM OF THE SCIENCES.

In the objects of nature science discovers consistencies and conformities in properties, in relations, in recurrent actions,

and in reproductions of kind, and even in variations that are reducible to natural "laws". There is furthermore revealed an interdependence of systems, a coherence, a unity, and in some systems a determination of organization, or of functions and processes, if not a teleological purpose. The concept of the *order of nature* has thus developed in correlation to a real order in nature. The *order,* however, is to be distinguished from the *system* of nature, whether real or conceptual.

The system of the sciences is broadly a synthesis of concepts and conceptual relations, believed to be correlative to objective realities and real relations. Conversely, the systems of nature are discovered and synthesized by science, and the real universe is revealed, tho imperfectly, to human intelligence. The system of verified knowledge progressively reveals reality. The intellect aspires ultimately to comprehend the universe. This intellectual tendency is in some minds consciously purposive. In religious minds the purpose is regarded as related to a universal purpose that is causative, or teleological, creative or divine.

The data and the concepts of science in endless diversity are so interrelated that the system is indeed unitary; yet for convenience, for interests or purposes we define or delimit studies and branches of science, of technology, of history, or of philosophy. Among these the general, the *fundamental,* and the theoretical are distinguished from the *derivative,* the descriptive, the *applied,* the "mixed", and the composite. The traditional distinction between the abstract and the concrete is untenable; and all the foregoing terms must be qualified as relative rather than distinctive.

Tho knowledge is unitary, interests are plural and distinct. From specialized knowledge certain concepts derive, certain problems and theories emerge; certain principles are basic to these, and certain methods are characteristic. About such nuclear concepts, principles, interests, and problems the seve-

ral sciences are centered, and so also are the sub-sciences, technologies, and branches of philosophy, some more special and concrete, others more general and abstract. Each may be said to have its specialty, and its individuality.

In so far as these several distinct sciences and studies may be grouped about dominant general sciences, concepts, or principles, and in so far as some of these groups are derivative from or dependent on the general and fundamental sciences, they may be said to be classified, and in this sense we may speak of the classification of the sciences. But the term *system of the sciences* is more appropriate. We should, however, avoid the misconception that thruout the system of the sciences we are dealing with *classes* of sciences. What we are dealing with are distinct individual sciences and subsciences and special *groups* of such, and an *order* of these.

To the natural and logical order the system of the sciences should conform, and in the consensus of scientists and philosophers it does so conform in broad outlines and even in details. This order is indeed conceptually extended beyond the range of the natural sciences to the psychological and the social sciences and is furthermore infused into the correlative branches of philosophy. In this *naturalistic* view the system of natural philosophy is consistent with the system of science. The natural order, the scientific order, and the logical order thus coalesce; and with these orders the conceptual order of the pedagogic consensus is, or tends to become, for the most part consistent.

Considering the relativity and the adaptability of classifications, the inherent consistency of the several views with the scientific and naturalistic order clearly indicates that this order should prove valid and adaptable to the majority of interests, scientific, philosophic, and pedagogic. For the apportionment of research and for the classification of books in libraries it would make for the *maximal efficiency*. In short, the scientific order is, as we have repeatedly emphasized, the

most adaptable to the several consistent views, the most efficient in serving the predominant interests, and the most practical for library classifications.

This order is no new discovery but has its long history extending back to the Greek "triad" of Logic, Physics, and Ethics. All thru the history the broad basic distinctions persist, and the historical connections are evident. The first division usually comprised the most general and abstract studies, the philosophical, metaphysics, theology, the formal, logic and mathematics. Then the physical, or natural, sciences were grouped. Finally, in some selection or combination, the sciences of humanity, the mental, social, ethical, and the *humanities,* comprising the history of civilization and the arts, including also the languages and literatures. The immense development and the intricate specialization of these studies in the past two centuries have complicated this system of knowledge but without radically changing the foundations. The modern system, maintained in the scientific, philosophic, and educational consensus, extends and expands, with but minor changes, its three-dimensional structure on those stable historic foundations.

3. THE DOMINANT LIBRARY CLASSIFICATIONS ARE DISQUALIFIED AS ORGANIZATIONS OF KNOWLEDGE.

But the established systems of classification for libraries do not adequately embody the principles that we have stated as essential. Those classifications do not conform to the scientific order. They have been constructed by those who did not rightly apprehend that order or who ignored it. The foundations of those systems were laid a half-century ago, or nearly, when the order was less clearly established in the consensus. Their makers were intent on constructing *practical* classifications, and they did not see that the better the

classification conforms to the system of science the more serviceable it will be, the more efficient, the more practical.

We are prepared to show in a subsequent volume how those classifications for libraries are disqualified as organizations of knowledge, both structurally and functionally. Their faulty divisions and their lack of scientific order result in a multiplicity of inconvenient separations of closely related subjects. In the presence of a great need for consistent order they present very obvious disorder. More than half their major divisions and subordinations are structurally wrong, and therefore in *collocation* of related subjects functionally they are proportionately far below *maximal efficiency*. Tho expansible, they are inordinately cumbersome, and therefore uneconomical. Established, tho neither uniform nor standardized, they are accepted tho admitted to be unsatisfactory — on the ground that no better systems are at present complete and published, and for other less valid arguments. They belong to the era of analysis and specialization rather than to the age of synthesis and organization; they belong to the past when documents were filed in pigeon-holes and business correspondence was copied in indexed books, or loosely filed in "letter-files" of literal confusion. That was the day of the *subject-index illusion,* that subjects might be cataloged alphabetically or classified in any order, or disorder, if only there be an alphabetic *relative index* to locate them in their disordered detail.

Now the tendencies to organization and reorganization are manifest, and the need for better classification in libraries is well recognized. The reputation of professional librarianship is involved. Change, however, alteration, reclassification would be troublesome and expensive. But the longer it is postponed, the more burdensome the inevitable change will be. This is the library side of the situation that we have surveyed. We would urge librarians and library trustees to give very careful consideration to the problem involved — to the facts we have stated, and to the principles we have adduced.

4. INTELLECTUAL VALUES SHOULD AVAIL.

This situation is, like others, affected by relative values and motivated by conflicting urgencies. The net economic cost of improved classification in a library is to be weighed against the resulting economies plus an estimable enhancement in educational and intellectual values. Libraries are educational in purpose; they are economic only by sheer necessity. To maintain any classification is a considerable cost; to maintain one inefficient in service is a veritable waste; to maintain one inconsistent with the organization of knowledge is to deny educational values for the sake of short-sighted economies. Where so much is expended on edifices and decorations and on collections and on maintenance, some small portion of the funds might well be invested in a structural and functional organization of knowledge furnishing higher and truer educational and intellectual values.

Our broadest view is that of the opening chapter, of the structural and functional organization of knowledge in relation to adaptive and progressive social organization. That relation was seen to be an effectual one, making for the rule of reason. The need for more adequate knowledge and more intelligent organization was averred to be of vital importance. Without more rational conservation of natural resources, more coöperative control of social economies, and more effectual educational guidance of mental and moral tendencies, the social organization would evidently degenerate. The scientific, technologic, economic, æsthetic, religious, and ethical interests that hope and endeavor to ameliorate the conditions of human life depend upon the organization of knowledge and the extension of education to all fields of social interest; and this in large measure depends upon consistent and efficient classification in libraries of the materials of study and research and of the literature of influence. These very important purposes should not be hindered by antiquated and inadequate systems maintained in the name of library economy.

A library is, we have said, a temple of knowledge. Those who enter may well be shown its internal organization, the structure of its functioning system. The plan, or scheme, of its classification of knowledge might well be exhibited in a synoptic table or chart; and in the several halls, or alcoves, or book-stacks, similar charts might display classifications of the respective branches of knowledge, with their subdivisions. This intrinsic structural organization of the human mind's most valuable temple, the synthetic system of living knowledge, intelligently comprehended, should be esteemed no less highly than the encasing ever-lifeless architectural stone.

BIBLIOGRAPHICAL NOTES.

A few books and essays that seem especially relevant to the interests and arguments of this book are briefly mentioned below. We have cited or quoted them before, some of them many times.

Becher, Erich. *Geisteswissenschaften und Naturwissenschaften: Untersuchungen zur Theorie und Einteilung der Realwissenschaften.* München, 1921, 335 pp. As a contribution to the solution of the problem of the partition or classification of the sciences and branches of philosophy, this book is more particularly discussed in Chapter XX, pp. 394–5. It does not, however, treat especially of the order or system of the sciences. It is important to our interest chiefly because of its careful and thoro treatment in support of certain basic principles that we have adduced. Tho we differ from Becher in certain other respects, we recommend his treatise to those who read German and who are sufficiently interested in the problem. Tho rather clear in its thought and not very difficult in its style, it is tedious reading, because abstruse and very repetitious. Those who dispute our arguments should, we suggest, be obliged to read this German work thruout by way, as it were, of retribution.

Flint, Robert. *Philosophy as Scientia Scientiarum and a History of Classifications of the Sciences.* Edinburgh, 1904, 340 pp. This work is the accepted authority for the history of the subject. Its criticisms are nearly always penetrating, valid, and judicious. The introductory essay on Philosophy as the science of sciences is very estimable. Professor Flint was well qualified both in science and in philosophy. His books on the Philosophy of History and on *Theism* and *Agnosticism* had previously achieved a good reputation. This history of classifications would, however, have been more interesting, if it had been comparative rather than merely chronological in order. Tho authoritative and on the whole correct, it is not entirely free from errors.

Goblot, Edmond. *Le Système des sciences.* Paris, 1922, 259 pp. A much better book than his earlier *Essai sur la Classification des sciences,* (1898), more valid in its reasoning, more clearly thought, very readable, beautifully written. We would recommend it to those who would like to pursue the subject philosophi-

cally. M. Goblot seems too positive, however, in excluding the arts from the system of the sciences, nor does he sufficiently recognize the relations between the sciences and the several branches of history. From the point of view of the organization of the sciences as a system he takes too little account of the special branches of the sciences and other related studies.

Ostwald, Wilhelm. *The System of the Sciences.* An address at the opening of The Rice Institute in Houston, Texas, published in *The Book of the Opening,* in 1916 (v. 3, pp. 788–867). This extended essay begins with a powerful plea for organization in science as a necessary means to development and to service of human needs. Ostwald was a masterly scientist and an impressive thinker. He appreciated the unity of the system of science and regarded demarcation as relative and provisional. Tho he did not work out a classification of sciences in detail, he outlined in this address, and in his earlier book on Natural Philosophy, a scheme that is, as we have elsewhere shown, consistent with the scientific order, valid, and nearly correct.

Richardson, Ernest Cushing. *Classification, theoretical and practical,* New York, 2nd ed., 1912. Containing a discourse on classification and a chronological catalog or bibliography of historic systems, first those theoretical, then those practical, with citations and annotations, and outlines of some of the most important systems, this little book has been especially acceptable to librarians and bibliographers.

Shields, Charles Woodruff. *The Order of the Sciences.* New York, 1882. This little book, now become rare, embodied a remarkable essay, historical, critical, and constructive, on "the philosophical classification and organization of human knowledge", which was incorporated in the third edition of the author's larger work entitled *Philosophia Ultima,* (2 v. 1888–9). This essay and its classification have been praised in Chapter XX, § 3, and that larger work is cited more precisely in the footnote on p. 389. Tho not intended as a basis for a practical system of classification but as part of a system of philosophy, that essay stands as one of the most valuable contributions to our subject.

Stumpf, Carl. *Zur Eintcilung der Wissenschaften.* In K. Preussische Akademie der Wissenschaften, *Abhandlungen, Philosophische-Historische Classe,* 1906, V, pp. 4–94, Berlin, 1907, quarto. This philosophical discourse was the precursor on which Becher's evidently most largely rests. It is clearly and admirably written and more readable than Becher's treatise, but less complete, less elaborately developed, and less closely reasoned. Its conclusions are on the whole valid and consistent with the consensus of science. Like Becher's book, it is concerned more with distinctions

and divisions than (like Erdmann's important contribution — cited elsewhere — and Wundt's and Ostwald's) with the system and order of the sciences and branches of philosophy.

Wundt, Wilhelm. *Über die Eintheilung der Wissenschaften.* In *Philosophische Studien, herausgegeben von Wilhelm Wundt,* Band 5, 1889, pp. 1–55. This masterly essay has been cited, commended, and criticised in preceding pages. It is a historical and critical study of the principles of the classification of the sciences and the branches of philosophy, and of the chief historic systems, followed by a statement in some twenty pages of Wundt's own system, with tables.

INDEX

INDEX

In this index two kinds of sub-headings are distinguished and grouped. (1) The specific term is subordinated with indention and initial capital, without repeating the generic term, tho this is sometimes indicated by its initial capital. (2) A dash represents each leading term, and the specific terms follow without capitals, except for proper names. There are a few cross-references. For the larger subjects cross-references seem unnecessary.

A

Abscissio infiniti, 152, 215.
Abstract sciences, 198, 255, 258, 350;
— — in Comte and Spencer, 344–7;
— — — Giddings, 360.
Abstract-concrete "blunder", 350 ff.
Abstracting, Coöperative, 47;
— service, abstracts, 98.
Abstraction, 122, 215;
Abstract idea, 121–2.
Accidents (logic), 121, 135.
Administration, 294;
International Congress of Administrative science, 32.
Adult education, 53, 58;
— — thru libraries, 92, 101–2;
— — — museums, 91;
American Ass'n for, 53;
American Library Ass'n Board, 79;
European Ass'n for, 54;
World Federation for, 54.
Advertising, 57;
Wastes of, 42.
Aerodynamics, 208.
Æschylus' *Prometheus* mentioned, 7.
Æsthetics, 296–7.
Agriculture, Internat'l Inst. of, 25.
Alembert, D', *Encyclopédie,* 333.
"Almosters", 388 ff.
Alsted's *Enclopœdia,* 334.
Ambiguity in words ending *ion,* 142.
Amelioration, Social, 43 ff.;
Ameliorative social work, 291.
American: for names of Associations and other organizations see under the distinctive word of the name, e.g., Bankers' Ass'n, American. But a few exceptions follow.
American Legion, 44.
— Ass'n for Advancem't of Science, 64;
Order of Sections, 397;
A suggested alteration, 398.
Ampère's classification, 336–8;
— — best to its date, 353.
Analogy of the helix in class'n, 231, 401;
— — — — tree, 155–6, 231, 245, 253, 255, 256–7, 407;
— — — — trellis, 245–6, 407;
— — — — triangle, 401.
Analysis (logical), 71–2, 135, 136, 140, 163–4, 167;
Mathematical, 247.
Anarchy, 10.
Anatomy, 275.
Ancillary studies (historical), 285.
Andrews, C. W., cited, 115.
Angell, J. R., quoted, 287.
Anthropogeography, 269, 283.
Anthropological sciences, 203, 279.
Anthropology, 200, 203;
Culture A., 282;
Ethnic A., 282, 283;
Physical A., 260, 278, 279;
Racial A., 278, 280;
Taxonomic, Zoölogical, 279.
Apperception, 83, 85.
Arbitration, 35–6;
— Ass'n., American, 35;
Coöperation in A., 36.
Archeology, 285.
Archivistics, 285.
Aristotle, quoted, 309;
His distinctions, 309;
Productive sciences in A., 328;
Typical of the naturalist, 400.
Arnott, Neil, Class'n of, 335.

Art, Arts, 295;
Expressive, 296–7;
Fine, 296–7;
Graphic, 297;
Imitative, 296;
Industrial, 295;
Plastic, 297;
Productive, 295;
Recreative, 297;
Representative, 296;
Technical, 295;
Useful, 296;
Arts and sciences, 328 ff.;
— — in the systems of:
Aristotle, 328;
Bacon, 329;
Cassiodorus, 328;
Hobbes, 329;
Hugo of St. Victor, 328;
Isidore of Seville, 328.
Art interests, organized, 55.
Associated Press, 100.
Astronomy, 205, 269.
Auxiliary sciences (historical), 285.
Aviation, 208.

B

Babson Institute, 27.
Babson's Statistical Organizat'n, 27.
Bacon, Francis, System, 316–20;
Advancement of Learning, 317;
Arts in, 329;
De Augmentis, 317;
Partitiones scientiarum, 318.
Bacteriology, 204.
Bagley, W. C., quoted, x, 83, 86.
Bain, Alex., Class'n, 351–2;
— — best to its date, 353.
Baldwin, J. M., cited, 9.
Bankers' Ass'n, American, 29.
Barnes, H. E., cited, 59, 79, 287, 289.
Barrell, Joseph, cited, 180.
Barry, Frederick, cited, 7, 13, 190, 192; quoted, 193, 206, 210.
Barthel, E., System of, 387.
Battezzati's system influenced Melvil Dewey's, 372.
Baumgarten's *Æsthetica*, 329.
Bayle's *Dictionnaire*, 332.
Becher, Erich, cited, 124, 243, 379, 384;
System of, 394–5;
— Critical note on, 415.
Beer, Henri, cited, 287.
Behavior, 275.
Bentley, Madison, cited, 117.
Bentham, Jeremy, System of, 330.
Bibliography, 79, 80, 102–3;
Bibliographic services, 98, 102–3;
Internat'l, 47, 48, 55, 59, 67;
Catalog of, 109–10.
Bibliothecal services, see Libraries.
Biogeography, 269.
Biological analogies, 8, 77.
Biological sciences, 271, 276.
Biology, 275;
— complex, 246;
Branches of, 201–2.
Bio-psycho-sociologie (Goblot), 363.
Bishop, W. W., quoted, 110.
Björkman, Edwin, quoted, 8.
Blackmar, F. W., quoted, 379.
Bliss, H. E., cited, 115, 130, 159;
System of, 252, 397.
Books, Knowledge organized in, 81, 93.
Bordeau, L., System of, 386.
Botanic harmonies, 184.
Botany, 276.
Brain is organic, 77.
Bridgman, P. W., cited, 274.
Bridgewater Treatises, 170.
Brinton, D. G., cited, 283.
Broad, C. D., on *sensa*, 172.
Brown's class'n, 107.
Brunet's *Manuel*, 106.
Brunhes, Jean, cited, 285.
Business, 295.
Butler, N. M., quoted, 29.

C

Caldwell, O. W., cited, 65.
Cambridge Modern History, 286.
Campanella, System of, 320–1.
Canners' Ass'n, National, 30.
Capella, see Martianus Capella.
Carnegie Corporation, 25;
— Endowment for Internat'l Peace, 24–5;
— Foundation, 25;
— Institution, 65.
Cassiodorus, 312.
Catalogs, Classified, 106.
Catalogue raisonné, 106.
Categories of entity, natural, 176.
Catholic Church, Roman, 44.
Cattell, J. M., cited, 64, 68.
Cause, causation, 272.
— viewed sequentially, 242;
Determinative relations, 177;
Efficient C., 272;
Final C., 272;
Teleological, 272.

"Celestial harmonies," 184.
Cells, 271.
Century Dictionary, 335.
Chamber's *Cyclopædia*, 332.
Characteristics, 121, 134.
Charity, Organized, 291.
Charters, W. W., quoted, 86.
Chemistry, 264, 265;
Physical, Theoretical, 266.
Christian Science Church, 44.
Chronology, 285.
Churches, Organizations of, 44;
— of Christ, Federal Council of, 44.
Civic Ass'n, American, 31.
Civic Federation, National, 34.
Civil Service Reform League, Nat'l, 34.
Clarification of thought, see Intellectual C.
Class, classes, 118 ff.;
— conceptual, 123, 124, 125;
— correlated to concept, 120;
— defined, 119, 132–3;
— developmental, 120;
— is a totality, 120, 132;
— — relative, 123;
— may be real, 125;
— of classes, 125;
Natural classes, 119.
Classification, 118, 142 ff.;
— defined, 143–4;
— in sciences, 236;
— of knowledge, 59, 80; See also Knowledge, Organizat'n of.
— — — adaptable, 95, 150, 244;
— — — a problem, 237, 238, 388, 398;
— — — if general, is permanent, 157, 211;
— — — impaired by dichotomy, 338, 399;
— — sciences, 213, 215, 236; See also Sciences, Organization of.
— — — is developmental, 399;
— — — — grouping, not classifying, 237, 277, 410;
— — — — permanent, 209, 211, 219, 222, 231, 399;
See also General Classes.
Arbitrary, artificial C., 151;
Bibliographical C., 106, 237;
Branching, 151, 245–8;
Complex, 155;
Conceptual, 148;
— does not falsify realities, 220;
Correlated orders of, 226, 227, 229;
For the several orders, see under the distinctive terms.
Cross-classification, 151, 358–9 ff.;
Classification (*continued*)
Diagrammatic C., 151, 154;
History of C. of sciences, 307;
Library C. (for libraries), xv, 102–3, 108, 411–4;
Adjustable, 107;
Better C. advocated, 112, 412–4;
Conservatism in, 103 ff., 108, 109;
Expansive, 107;
Inadequate, 103 ff., 108, 109–15;
Practical, 103–4, 107, 113;
Problem of, 110–12;
Scientific is practical, 113–5;
University libraries' C., 115.
Limitations of C., 147–8;
Natural C., 149, 186, 231, 239, 244;
Philosophic, 240;
Practical C., 151, 244;
Principles of C., 156–7;
Purposive C., 150, 244;
Relativity of C., xii, 123, 147–8, 150–1, 239, 243–4;
Scalar C., 153, 249, 408;
Schedulizing C., 248–9;
Scientific, 150, 186, 214, 243;
Serial C., 151, 153, 155, 249, 408;
Structural C., 80, 237–9, 401;
Three-dimensional C., 201, 246, 276, 407.
Classificatory order of facts, 242.
Classifying, 143, 145.
Clifford, W. K., mentioned, 198.
Coetlogon's *Arts and Sciences*, 335.
Coffey's *Logic* cited, 126, 127, 139; quoted, 125.
Coleridge's system, 331, 334.
Comenius' system, 322.
Commerce, 295.
Commonwealth Fund, 65.
Community, 171, 292;
— organization, 30, 32–3;
— — chart, 33.
Compagnons de l'Intelligence, 48.
Competition, 43.
Complex, mental, 165;
— psychical, 216;
Complex concepts, 159;
— entities, 158–9;
Comte, Auguste, "hierarchy," 222, 341;
— — order of the sciences, 215, 225, 341.
Concept, 120, 216;
— is the abstract idea, 120–1, 216;
— — the correlate of the class, 120, 216;
— — developmental, 120, 122;
— — experiential, 122;
— — subjective, 122.

Conceptualism, 127.
Concrete sciences, 198;
— — Comte's and Spencer's, 345–7.
Conformity to constant relations, 176;
— — natural law, 177.
Congress of Arts and Science, 331, 375, 399;
Table of order of sections, 378–9.
Constancy of relations, natural laws, 177, 194.
Conklin, E. G., quoted, 2, 8, 75, 185, 274.
Consensus, educational and scientific, 16, 300, 301.
Conservation of Energy, 176;
— — matter, 176.
Conservatism, 15.
Conti, System of, 371.
Cooley, C. H., cited, 9, 17, 57.
Coöperation, 7, 8, 16, 20, 26, 28, 35, 37, 46, 59, 60, 405;
Consumers' C., 30.
Lack of, 3, 6, 21;
— lacks knowledge, 3, 4, 6;
Coördination, 152, 154;
— and subordination combined, 153, 154;
— — — relative, 153.
Corleo, System of, 372.
Corneille, Thomas, *Dictionnaire,* 332.
Correlation, 177.
Correlation, educational, 84, 85;
— of studies, ix, 47, 51, 84.
Cosmology, 256.
Council for Education, American, 50.
Cournot's system, 339.
Court of International Justice, 23.
Creation, 271.
Credit Men, Nat'l Ass'n of, 29.
Cross-classification, see Classification.
Crookes, Sir Wm., mentioned, 208.
Crystallography, 204, 269.
Culture-epoch theory, 87, 227.
Curriculum, 79, 228;
Reorganization of, ix, 88.
Cutter, C. A., mentioned, 105;
"Expansive Class'n", 105.
Cytology, 206, 275.

D

Decimal Classification, see Dewey, Melvil.
Definition, 134 ff., 141;
— is adaptable, 136, 139;
Analytical D., 136;
Definition (*continued*)
Comprehensive D., 136;
Diagnostic D., 136;
Relation to class, 134, 136, 138;
Scientific D., 136–7.
Description, 135.
Destutt de Tracy, System of, 368.
Determinism, 271.
Deutscher Normenausschuss, 38.
Development, gen'l, 179;
Development (Biology), 182, 270; 271;
Developmental order, 222, 224, 230, 233;
— — crosses the logical, 225;
Developmental relations, 178.
Dewey, John, cited, 16, 137, 191, 228; mentioned, 88; quoted vi, 58, 70, 114, 122, 165.
Dewey, Melvil, mentioned, 104–5; *Decimal Class'n* of, 104, 110;
— — related to Italian Baconists, 372.
Diagnosis, 141;
Scientific, 194.
Diagrams, 154.
Dialectics (Greek term), 311.
Dichotomous branching, 247.
Dichotomy (logical), 140–1, 152;
Exhaustive D., 152.
Dictionaries, Historic, 331 ff.
Diderot's *Encyclopédie,* 333.
Dieserud, Juul, cited, 283; quoted, 109.
Differentiation, 140; see also Specific differences.
Diplomacy, 294.
Diplomatics, 285.
Division, Logical, 139–40.
Drama, Dramatics, as arts, 298–9.
Driesch, Hans, quoted, 273.
Dunlap, Knight, cited, 17, 131; quoted, 58.
Dualistic distinctions, 376–7.
Dynamics, 267.

E

Earth, Evolution of the, 180;
Earth sciences, 269.
Ecology, 275.
Economics, 294.
Edman, Irwin, cited, 177, 192.
Educational associations, 46.
Educational psychology, 280.
Educational sociology, 280.
Educational values, ix, 114–5, 413–4.
Educational viewpoint, 241.

Education, 280;
— for social life, 5;
— should be adaptive, 14;
— — organize experience, 88;
— — — knowledge, 88, 238;
— synthetic, 228;
Primary, 228;
Secondary, 228.
Edwards, A. S., quoted, 85.
Edwards, Edward, *Memoirs of Libraries,* cited, 106, 329, 339.
Embryology, Embryogeny, 275.
Empirical, term defined, 190.
Encyclopedias, 96, 331 ff.
Encyclopædia Britannica, cited, 312, 314, 332; mentioned, 335.
Encyclopédie (Diderot), 333.
Endocrinology, 206.
Energy, 264, 274;
Energetics, 264.
Engineering, 296.
— Standards Comm., American, 28.
Entelechy, 273.
Entomology, Economic,
U. S. Bureau, 64.
Epigraphy, 285.
Epistemology, 254, 256;
— Viewpoint of, 262.
Erdmann, Benno, System of, 359–60;
Ersch and Gruber, *Encyclopädie,* 335.
Ethical systems, 240.
Ethics, 256, 289–90.
Ethnic Archeology, 284.
Ethnology, Ethnography, 200, 282, 283.
Ethology, 392.
Eucken, Rudolf, quoted, 221.
Europe, post-war conditions, 21.
Events regarded historically, 242.
Evolutionary order, 223.
Evolution, 178–9, 181, 271;
Organic E., 181, 182;
Purposive, teleologic, 183.
Evolutional relations, 178.
Exhibits, 89 ff.
Experience, Organization of, 16, 17.

F

Fascisti, 44.
Filiation of sciences, see Sciences, Filiation of.
Finance, 295.
Fisk, E. L., book quoted, 44.
Fiske, John, cited, 225;
— criticised Comte, 345;
— mentioned, 222.
Fletcher, W. I., mentioned, 105.
Flint, Robert, cited, 223, 307, 308, 311, 314, 316, 321, 322, 325, 327, 330, 333, 334, 336, 337, 340, 373;
— criticised Spencer, 349.
— in error, 362;
— quoted, 227, 251, 349;
Critical note on, 415;
Fluxions (term), 249.
Folk-lore distinguished, 200.
Formal sciences, 258.
Formal studies, 255.
Fossils, 271.
Franklin Institute, 65.
Freedom, 10–11.
Freudian "psychoantics", 216.
Function, correlative to organ, 77.
Function, mathematical, 177–8.
Functional relation, 177–8.
Fundamental ideas as basic to class'n, 369.
Furetière, Dictionary of, 332.

G

Geisteswissenschaften, 359.
Genealogy, 285.
Genera, 121, 135–6.
General, Generic classes, 121, 216;
— relatively permanent, xiii, 121, 157, 209–11, 221.
General ideas, 121, 216.
— methods of science, 255.
Generalization, 121, 215, 216;
— in science, 193.
Generic images, 121.
Genetic relations, 178.
Genetics, 276.
Geography, 285;
— composite, 203;
Human G., see Anthropogeography.
Physical, Physiography, 269.
Geological sciences, 269.
Geology, 269.
Geometrical diagrams for triads and circles of studies, 401–3.
Germany's organizat'n of knowledge, 62, 65.
Gesner's system, 329, 334.
Gibson's *Logic* quoted, 127, 137, 139, 148, 216.
Giddings, F. H., cited, 293;
quoted, 281, 291;
Class'n of, 360–2;
Cross-class'n in, 361;
Comte criticised by, 360.
Givler, R. C., cited, 289.

Goblot, Edmond, cited, 237;
critical note on, 415–6;
quoted, 188, 288;
Class'n of, 363;
Système des sciences, 365;
God, 170, 172, 174, 262, 264, 287.
Gradation by speciality, 217, 219, 226, 231, 249, 277, 358, 400, 408.
Graphics, graphs, 154.
Gray, L. H., quoted, 289.
Greek triad, see Stoic triad.
Green, T. H., cited, 126.
Group distinct from class, 131–2.

H

Haldane, R. B., quoted, 162.
Hale, G. E., quoted, 67–8.
Hankins, F. H., cited, 80, 192;
Harnack, Adolf, quoted, 289.
Harris, E. P., cited, 30.
Harris' *Lexicon,* 332.
Hartwig's *Schema,* 106.
Health organizations, 45;
Internat'l Health Board, 45;
National Health Council, 45.
Hegel's *Encyclopedia,* 326.
Helix analogy for class'n of knowledge, 231, 401.
Henderson, L. J., quoted, 75, 116, 175, 183.
Henderson, E. N., quoted, 83, 84, 88.
Heraldry, 285.
Histology, 275.
Historical aspect of events, 242;
— order of the sciences, 222, 224–5;
— viewpoint, 242, 243.
Historiography, 251;
Historiology, 251.
History, 286;
— comprehensive, 286;
— distinguished from science, 286;
Every subject has its H., 242, 286;
"New history", 286;
Philosophy of H., 195;
Social-political H., 284–5.
Hobbes, System of, 321–2;
Arts in, 329.
Hobson, E. W., cited, 122, 196.
Hobhouse, L. J., cited, 172; quoted, 17, 74, 165, 195–6.
Hoffman, F. L., cited, 66; quoted, 109.
Hoffman, F. S., Class'n of, 386.
Holland, Lord, quoted, 61.
Hoover, Herbert, quoted, 28.
Hopes, Great, 21–6.
Hopkins, A. H., quoted, 110.
House, E. M., book cited, 21.
Howard, L. O., quoted, 65.
Howe, F. C., book cited, 30.
Hugo of St. Victor, 312.
Arts in Hugo's system, 328.
Human nature, 6, 15, 88.
Humanistic view, 241.
Humanities, 260, 286, 299.

I

Idealism, 126, 128, 169, 170, 264.
Identity and sameness, 160.
Ideology, 368.
Immaterial entities, 273–4.
Individualism, 10, 19;
— and society, 6, 8, 9;
— — socialism, 10, 11.
Industrial Conference Board, Nat'l, 29.
Industrialism, 19–20.
Institute of Politics, 32.
Integration to mitigate specialization, ix, 47, 73, 375;
See also Synthesis.
Intellectual clarification, 3, 47, 116, 141, 237;
Intellectual coöperation, ix, 46 ff.;
League of Nations Comm. on, 47;
— — Internat'l Institute of I. C., 46, 48, 50;
— productions, selecting, abstracting, etc., 47;
— workers, 47 ff.;
— — Federation of, 48;
— — International Congress of, 49;
National ass'ns of, 49.
Intelligence, Dissemination of, 32, 58–60;
See also Adult Education.
International ass'ns, etc., see under the distinctive terms.
— — Union of, 66.
— Association of Academies, 61–2.
— Education, Inst. of, 25, 50.
Internationalism, 20–1.
Isidore of Seville, System of, 312;
Arts in, 328.
Italian system-makers, 370, 372.

J

James, Wm., quoted, 116, 193.
Janelli, System of, 371.
Janet, Paul, quoted, 337;
System of, 373.

Jastrow, Joseph, quoted, 199.
Jevons, W. S., cited, 136; quoted, 119, 145, 259.
Joseph's *Logic*, cited, 126, 127; quoted, 141, 148.
Journalism, 58, 95, 97, 99, 298.
Jurisprudence, 293, 294.

K

Kant's system, 324.
Kelley, Grace O., quoted, 111.
Keynes' *Logic*, cited, 133.
Kinds, Natural, 119.
Kinematics, 267.
Kinetics, 267.
Knowledge, analytic and synthetic, 252, 407;
Common K., 57, 94, 99;
Encomiums of, 7;
Humanizing K., 7, 47, 101;
See also Common K.
Interrelations of branches of, 51;
Organized, organization of, 18, 26–7, 47, 56 ff., 59, 65–6, 77, 81, 93, 299 ff.;
— in education, 81–2, 85, 87, 88;
— is adaptive, 406–7;
Kinds of, 78, 80;
Need for, 3, 5, 69, 405;
Progressive, 27 ff., 94;
Popularizing, 101;
Relativity of, 161–2;
Synthesis of, See Synthesis.
System of, historical, 411;
— surveyed, 299 ff.;
Unity of K., 166, 300, 304;
Values of K., 7–8, 26;
Intellectual V., 413–4.
Krug, Wilhelm, System of, 325.

L

Lablanca, System of, 371.
Labor, American Federation of, 30.
Labor Organization, Internat'l, 23.
Ladd, G. T., cited, 243; quoted, 185.
LaGrasserie, Raoul de, System of, 373.
Laisant, C.-A., quoted, 199.
Lamprecht, Karl, quoted, 286.
Lange, Karl, quoted, 83.
Language, as an art, 297–8.
Lankester, E. R., quoted, 69.
Larousse, *Dictionnaire*, 335.
Law Institute, American, 36, 65.
Law, Philosophy of, 293.
Lawlessness, 10.
Laws of nature, scientific, 177, 194;
Political, 10–11, 18, 194, 294.
League of nations, 22–3;
International Bureaux of, 24.
Learned, W. S., book quoted, 79.
Learning, Natural, primitive, 227.
Leibniz, quoted, 258;
System of, 323.
Lewes, G. H., quoted, 341, 349.
Liberal arts, The seven, 311.
Liberalism, 11, 13.
Liberality, libertarianism, 13.
Liberty, 10.
Librarians, etc., Internat'l Congress of, 54.
Librarianship, Service the ideal of, 104, 108.
Libraries, are educational, 102;
Adult education in, see Adult Education.
Classification for, see Class'n.
Efficiency thru logical order, ix, 112;
See also Maximal efficiency.
European L., 106;
Functional organization, 101–3;
International services, coöperation, 47, 52, 54;
Knowledge organized in L., 81, 94;
Social importance of, vii–viii;
Library Ass'n, American, 52.
Library of Congress, Class'n, 107, 110.
Library school, Paris, 52.
Life, dependent on knowledge, vii;
Essentials of, 270, 272.
Likeness, a relation, 160, 177.
Lindsey, Ben, cited, 13.
Linguistics, 298.
Lippmann, Walter, cited, 58; quoted, 46.
Literature and philosophy, 299, 304;
— as an art, 298;
Criticism and appraisal of, 59.
Littré, M. P. E., defended Comte, 345.
Livingston, B. E., quoted, 66–7.
Logic, 258–9;
— in Aristotle's system, 310.
Logical division, see Division, logical.
— order of sciences, branches of knowledge, 87, 223, 230, 235.
Lotka, A. J., cited, 180; quoted, 270.
Lotze, Hermann, quoted, 126.
Luchaire, Julien, book cited, 48.
Lull, R. S., book cited, 180.

M

McClenahan, B. A., quoted, 31.
McDougall, Wm., quoted, 291.
McGilvary, E. B., cited, 381.
Mach, Ernst, quoted, 265.
MacIver, R. M., quoted, 9, 31, 78.
McMurray, C. A., quoted, 83, 84, 87.
Manufacturers' Ass'n, American, 29.
Marett, R. R., quoted, 289.
Marshall, H. R., æsthetic system, 244.
Martianus Capella, *Satyricon,* 311.
Marvin, F. S., quoted, 2.
Masaryk, T. G., System of, 356–7.
Materialism, 264.
Mathematics, 258, 259.
Matter, 264, 274.
Maximal efficiency, xiii, 238, 244, 301, 401, 408, 410.
Mechanics, 267.
Mechanistic doctrine denied, 273.
Mental development, 164;
— sciences, 260, 372;
— synthesis, see Synthesis.
Merlin, R., Catalog of, 106, 338–9.
Merriam, C. E., book mentioned, 32; quoted, 32, 35.
Metaphysical grounds, 377.
Metaphysics, 256, 262.
Aristotle's, 309.
Scope of M., 250.
Meteorology, 205.
Methodology, 259.
Mezes, S. E., mentioned, 21.
Militarism, 19–20.
Mill, J. S., cited, 143, 149; quoted, 119, 137;
— criticised Spencer, 349;
— defended Comte, 345.
Mind, 164, 261; See also Mental.
— organized, 77–8.
Mineralogy, 204, 269.
Mnemic relation, 178, 183.
Monographic studies, 204–5.
Morals, morality, science of, 290.
Morgan, C. Lloyd, quoted, 300.
Morgan, T. H., cited, 77, 178, 273.
Moréri, *Dictionnaire,* 332.
Morphology, 276;
Causes of, 179.
Motion-pictures, 55;
— — producers . . . of America, 55.
Moulton, Lord, quoted, 5.
Muir, Ramsay, quoted, 11.
Municipal League, 31.
Municipal Research, Bureau, New York, 34;
— — — Westchester Co., 34.
— Review, 31.
Münsterberg, Hugo, class'n, 375; quoted, 168, 375, 376, 377, 379.
Museums, 89 ff.
Music, 297–8.
Mutation (biological), 182.

N

Names, 138–9.
National Ass'ns, etc., see the distinctive term of the name, except
National Education Ass'n, 52.
Nationalism, 19–20.
Nature, What is meant by, 173.
See also Order of Nature.
Natural history, 269;
— order of the sciences, 87, 219, 221, 222, 223, 229, 232;
— philosophy, 250;
— resources, 4–5;
— sciences, 260, 263, 274;
— theology, 256.
Naturalistic view, 88, 239, 253, 261, 262, 372, 410;
See also Realism, naturalistic.
Naturwissenschaften, 359.
Naville, Adrien, Class'n of, 365–7.
Newcomb, Simon, quoted, 167.
Nernst, Walter, quoted, 266.
New England traditions, 292.
Newman, H. H., cited, 270.
News agencies, newspapers, news syndicates, 100.
Nomenclature, 139;
Names of sciences, 250.
Nominalism, 126.
Normative political studies, 294;
— sciences, See Sciences, Normative.
Numismatics, 285.
Nutting, P. G., quoted, 63.

O

Objective view, 254, 372.
Oil Conservation Board, Federal, Report, 5.
Oken, Lorenz, System of, 326.
Ontogenesis, 271.
Ontogeny, defined, 182, 275.
Opinion, Public, 16, 99;
Organization of, 32.
Optimistic view, 19.

Order of Nature, 170 ff., 181, 409;
— is comprehensive, 183;
— — conceptual, concept of, 175;
— — defined, 183;
— — developmental, 175;
— — real, realities of, 176–8, 183–6;
Rhythm of the Order, 185.
Organ, defined, 74–6;
— and function correlative, 77;
Organic, defined, 271;
Organism, defined, 74–6;
— dependent on its parts, 75, 172.
Organization, defined, 74–6;
— implies order, 59;
— should be adaptive, 11, 406–7;
— — — liberal, 11, 407;
— — — progressive, 12, 18, 407;
Analogies of, 406;
Coöperative O., 63 ff.;
Functional O., 15, 17, 45, 56 ff., 63 ff.;
Kinds of O., 18, 27;
Social O., 18, 20, 57;
— — awry, 19;
— — based on organized knowledge, 8, 405;
Progress in S. O., 29 ff.
Organization of, etc., see under the distinctive terms.
Ostwald, Wilhelm, cited, 237, 270;
quoted, 188, 207, 210, 218, 265;
Critical note on, 416;
System of, 392;
— — almost correct, 400.
Overstreet, H. A., quoted, 288.

P

Page School of International Relations, 25.
Paleoethnology, 284.
Paleography, 285.
Paleontology, 271, 276.
Pamphilis, Subjective class'n of, 373.
Pan American Union, 29.
Panckouke, *Encyclopédie,* 333.
Parker, S. C., quoted, 86.
Parliamentary Union, Internat'l, 32.
Part-whole relation, 74, 75, 171–2.
Patriotic organizations, 44.
Paulsen, Friedrich, quoted, 291.
Pearson, Karl, cited, 162; quoted, 192, 196;
Class'n of, 353–5.
Pedagogic order, 226–8, 230, 234.
Pedagogics (term), 250.
Periodical publications, 97–8.
Perkins, F. B., mentioned, 105.
Persistence of Energy, or force, see Conservation of Energy.
Persistence of substances, 176;
Philanthropy, 291.
Philology, 298.
Philosophical abstractions, 193;
— questions, 171, 193.
Philosophy, 193, 255–7;
— of human nature, 256;
— — knowledge, 254;
— — life, 254;
— — nature, 254;
— — religion, 254, 256.
Phoronomy, 393.
Phyllotaxis, 246–8.
Phylogeny, defined, 182, 276.
Physical Chemistry, 206, 266.
Physical conformities, 185;
— sciences, 260, 263, 275.
Physics, 264, 265, 275;
Applied P., 267;
— of the æther, 267;
Special P., 267;
Tabular synopsis of, 268;
Wonders of, 209.
Physikalisch-technische Reichsanstalt, 38.
Physiography, 269.
Physiology, 204, 275.
Phytogeography, 269.
Picard, Émile, quoted, 306.
Pittsburgh, Survey, 31.
Planetary motions orderly, 184.
Plasticity of bodies, forms, 176.
Plato's distinctions, 308;
— *Republic,* quoted, 306;
— typical rationalist, 400.
Pneumatics, 208;
— in Alsted, Arnott, and Leibniz, 342.
Pneumatology (Bentham), 342.
Poetry as an art, 298, 299.
Politianus, see Poliziano.
Poincaré, Henri, quoted, 166, 220.
Political economy (term), 249, 294;
— intelligence, 58;
— "prudence", 32;
— relations, 292–3;
— research, 34–5, 58;
— — bureaus, 34, 58;
— science, 292–3.
Politics (term), 250, 293.
Poliziano (Politian), *Panepistemon,* 315.
Polytechnics, 295.
Poole, Ernest, quoted, 9.
Porphyry, Tree of, 153.
Pratt, J. B., cited, 128; quoted, 129.

Practical philosophy, 256;
Aristotle's, 309–10.
Precursors of science, 314–22.
Prediction, scientific, see Science, prediction in.
Progress, 14, 94.
Social P., 6–7, 12, 14, 15, 26, 27 ff., 291.
Propaganda, 58.
Properties, 121, 135.
Proteins, 270.
Protoplasm, 270.
Protestant Episcopal Church, 44.
Protistology, 276.
Psychological implications, 77;
— sciences, 260, 279, 372;
— systems of knowledge, 367;
— view, 241, 243, 262.
Psychology, 278, 280, 367;
— in Kant, Hegel, and Comte, 342.
Future possibilities of, 209.
Psychical research, 209.
Public opinion, see Opinion, Public.
Publishing, publishers, 47, 59, 95 ff.;
Early, 96;
Organizing knowledge, 96–9.
Puritanism, 292.
Purpose, 20, 59, 169, 172, 271; See also teleology.
Organization of, 15 ff., 16, 18, 26, 27, 45, 57, 59.

Q

Quadrivium, see *Trivium et quadrivium.*
Quanta (physics), 274.

R

Radio-communication, 191, 209.
Radiology, 208.
Railway Economics, Bureau, 29.
Ramsay, Sir Wm., quoted, 266.
Ramus, Tree of, 153.
"Rationalization", 12;
Economic, 37.
Ratzel, Friedrich, cited, 283.
Ratzenhofer, G., quoted, 281.
Realism, 126, 128–9, 264;
Critical R., 127–8, 129, 172;
Naturalistic R., 129, 171–2, 175;
See also Naturalistic view.
— — adopted, 239;
Platonic, 126;
Scientific, 127, 129.
Reality, defined, 129, 174;
Ultimate R., 169.
Realization, intellectual, 169, 174.
Recurrence of phenomena, 177.
Red Cross, 44.
Reisch, Gregor, mentioned, 314–5.
Relations, 158;
— conceptual, 159;
— distinct from qualities, 159;
External and internal R., 158–9;
Real R., 159.
Relativity, 161–2;
— of Einstein, 162–3;
— — knowledge, 161–2.
Religion, 287–9.
Religious organizations, 44.
Reorganization, 15;
See also Organization.
Research, Coöperation in, 67–70;
Organization of, 61 ff.
Research Council, International, 66.
— — National, 63.
— Endowment, National, 69.
Residua in dichotomy, 140–1, 151–2.
Residual class, 140–1, 213, 296.
Rhetoric, 298.
Richardson, E. C., cited, 106, 312, 313, 314, 387; in error, 362;
Class'n of, 389–90;
— — almost correct, 400;
Critical note on, 416;
— criticised Congress of Arts and Science plan, 380.
Ritter, E. W., tribute to Scripps, 100.
Robinson, J. H., mentioned, 101; quoted, 286.
Rockefeller Foundation, 45, 65;
— Institute, 45, 65.
Root, Elihu, quoted, 67–8.
Rosmini, System of, 368.
Ross, E. A., quoted, 16, 17.
Royce, Josiah, quoted, 145, 219.
Russell, Bertrand, cited, 172; mentioned, 258.
Russell, William F., quoted, 50.

S

Sanctions, political, social, 18, 292.
Santayana, George, cited, 128.
Schäfer, Sir Edward, quoted, 270.
Schuchert, Charles, cited, 180.
Schuster, Sir Arthur, quoted, 61.
Schwartz, J., mentioned, 105.
Science, general, abstract, 189 ff., 197–8, 255–6;
— defined, 189–90;
— experiential, 190–1;

Science (*continued*)
— generalizes, 193, 195;
— impersonal, 192;
— instrumental, 212;
— methodical, 192;
— of order (Royce), 258;
— organized knowledge, 192;
— rational, 190;
— "Science Service", 100;
— social, coöperative, 191–2;
— super-national, 20, 66;
— systematic, 195;
— utilitarian, 201;
— verified, 192, 194;
Applied science, 211–13;
Complexities of S., 202–3;
Conceptual systems of S., 335 ff.;
Development of, 207–8;
Order of S., 168, 237;
Organization of, 61 ff., 66–9, 70–3, 188, 207–8, 236–7, 411;
Permanence, persistence of, 205–6, 209–11, 219, 221–2;
See also General Classes.
Prediction in, 194;
Scope of, 192, 195–6;
Survey of, 256;
System of, 70–3, 168;
See also Unity of S., and Sciences, System of;
Systemizing S., 237;
Theory, Scientific, defined, 194;
Unity of S., 70, 73, 166–8, 299, 306.
Sciences,
— centered about concepts, 217;
— distinct by concepts and purposes, 73, 384;
— dependent successively, 217, 225, 226;
— interdependent, 218, 225;
— grouped, not classified, 73, 237, 277, 410;
Abstract S., 197–8, 255, 258–9;
Applied S., 197, 211–3;
Biological, etc., see under the several sciences.
Branches of, 201–2;
Composite S., 202–3;
Concrete S., 198, 255, 258–9;
Deductive, demonstrative, 364;
Derivative, 199, 205, 218, 237, 351;
See also Sciences, dependent, and S., Filiation of.
Descriptive S., 198;
Exact S., 197–8;
Filiation of, 218, 222, 344, 349;
Foreign names of, 249;
Formal S., 359;
Fundamental S., 199, 201–2, 205, 218, 237, 351, 358;
Inductive, 364;
Interrelations of, 201;
Mental S., 372;
See also Psychological S.,
"Mixed" S., 212;
New sciences, 206–7;
Noölogiques, Sciences (Goblot), 364;
Normative S., 378, 386;
Precise S. (Pearson), 355;
Principal S. (Shields), 389;
Real S. (German), 359;
Serial dependence of, 300, 408;
See also Filiation, and Sciences, dependent.
Sub-sciences, 201–2;
Synoptic S. (Pearson), 355;
System of the S., 70, 73, 167, 237, 299, 410.
Scientific in part, Studies, 196.
— terms *abstract*, etc., not distinctive, 197–8; see also under the terms.
Scripps, E. W., mentioned, 100.
Scripps Institute, 65.
Selection of intellectual products, 47.
Sellars, R. W., cited, 128; quoted, 129.
Sequential, historical view, 242.
Shepard, W. J., book quoted, 58.
Sherman, S. P., mentioned, 13.
Shields, C. W., cited, 313, 314, 315;
System of, 388–9;
— — almost correct, 400;
— — critical note on, 416.
Shotwell, J. S., quoted, 284;
Sidgwick, Henry, quoted, 290.
Siegfried, André, quoted, 42.
Sigwart's *Logic*, cited, 127; quoted, 116.
Simonds, Frank, cited, 22.
Simplification, Economic, 37 ff.
Slosson, E. E., cited, 65.
Smith, Julian F., cited, 111.
Smithsonian Institution, 65.
Social, composite of individual, 226;
— organization, 18, 20, 57;
— organizations, 27–34;
— — need organized knowledge, 23, 45, 56, 59;
Social progress, see Progress, Social.
— psychology, 211;
— science, sciences, 281.
— survey, 32;
— Workers, Nat'l Conference of, 34.

Socialism, 10.
Sociology, 200, 281–2, 344.
Socrates, typical of humanistic view, 400.
Specialization, economic, 39, 41, 42;
Intellectual, viii, 47, 72.
Special Libraries Ass'n, Comm. on Class'n, 111.
Specific differences, 121, 135–6, 140;
— subordinated to generic, 121, 152–3, 214.
Specification, 121, 140, 216, 407;
Economic, 39–40.
Spencer, Herbert, cited, 215, 225;
quoted, 166, 199, 218, 222, 270;
— criticised Comte, 345;
System of, 345 ff.;
Abstract-concrete in, 346;
Divisions of, 346;
Series of, 348.
Sphragistics, 285.
Spring flowers, Succession of, 184.
Springfield Survey, 31.
Stability of natural systems, 176.
Stadler, Aug., System of, 362–3.
Standardization, 12, 37 ff., 40–1;
— adaptable and progressive, 41–3;
— *re* individuality, originality, 41–3;
American, 37, 39, 40;
Commercial, 38 ff.;
Coöperative, 41;
Economic, 37 ff.;
Engineering, 38 ff.;
European, 38;
Industrial, 38 ff.;
National Bureaus, Ass'ns, etc., 38–9;
Scientific, 37 ff.;
Technological, 38 ff.
Bureau of Standards, 38, 41.
Statistics, 259.
Stearns, A. E., book mentioned, 13.
Stoic triad, 254, 308, 311, 400.
Three types of views related, 400.
Stout, G. F., quoted, 300.
Strayer, G. D., quoted, 86.
Strong, A. H., cited, 128.
Stumpf, Carl, cited, 195, 197, 257, 367;
Critical note on, 416;
System of, 395–6.
Subject-index illusion, xii, 408, 413.
Subject-object relation, 128, 129, 159, 171, 372.
Subjective systems, 370 ff.
— view, 254, 372.
Subordination, 141, 152;
— of specific to generic, 121, 152–3, 157, 214, 408.
Suidas' *Lexicon*, 332.
Sulzer's view of the arts, 330.
Sumner, F. B., mentioned, 68.
Survey and "orientation" courses, ix, 256.
Syllabi, 59.
Synoptic tables of the orders, 229–36.
Synthesis, 71–2, 163–4, 407;
Intellectual, 166–8;
Mental, 164–5;
— of knowledge, 70–2, 166.
System distinguished from class'n, 148, 168.
Systems, Conceptual, 169;
Natural, physical, 169.

T

Tabulation, 154.
Tax Ass'n, Nat'l, 34.
Tansley, A. G., quoted, 165.
Teachers, American Federation of, 52.
Technology, 295;
Organization of, 39.
Telemnemy, 209.
Teleology, 183, 272, 409.
See also Purpose.
Teleological implications, 172.
Tennyson, Alfred, quoted, vi.
Terminology, terms, 139;
Ambiguous, 250;
Endings, suffixes, *ics, graphy*, etc., 250;
Linguistic, 249;
Subject-matter and study of, terms ambiguous, 250–1.
Testing Materials, American Soc. for, 29, 39.
Theistic viewpoint, 262.
Thomson, J. A., quoted, 181.
Thought, Organization of, 16, 99.
Tradition, 94, 292.
Tree, Trellis, Analogy to; see Analogy.
Trivium et quadrivium, 311, 328.

U

Union International des Villes, 32.
University libraries, Class'n for, see Class'n, Library, Univ.
University Professors, Amer. Ass'n of, 50.
University Union, American, 50.
United States Chamber of Commerce, 28.
— — Commerce Dep't, 28.
— — Government, Scientific organizations, 64–5.

Universe, 166, 167, 169, 173–4, 180;
— is real, 167, 174.
Unknowable entity, existence, 174.

V

Vaihinger, Hans, cited, 149.
Valdarnini, System of, 371.
Van Hoesen, H. B., quoted, 111.
Versailles, Treaty, 22.
Verworn, Max, cited, 270.
Vico, System of, 371.
Vitalism, 272–3, 274.
Voluntarism, 170.

W

Walcott, C. D., quoted, 4.
Wallas, Graham, cited, 17, 46, 211.
Warbasse, J. P., cited, 30.
Ward, L. F., cited, 215; quoted, 203, 207–8, 218–9, 221, 229.
Warren, H. C., quoted, 273.
Waste, Economic, 10.
Wells, H. G., cited, 287.
Welton's *Logic*, quoted, 137.
Wheeler, W. M., cited, 68.
Whewell, Wm., Class'n of, 369; quoted, 149.
Whitney, A. W., quoted, 43.
Will, Organization of, 16.
Williamson, C. C., cited, xiv.
Wistar Institute, 65, 98.
Women's clubs, Nat'l Federat'n of, 43.
Women Voters, League of, Nat'l, 44.
World, distinguished from nature, 173.
— Economic Conference, 39.
— Federat'n of Education Ass'ns, 51.
— Peace Foundation, 25.
— Power Fuel Conference, 5.
Wundt, Wilhelm, cited, 310; quoted, 197, 259, 347, 384;
Critical note on, 417;
System of, 381–4, 390–2;
— — almost correct, 400;
Divisions in, 383, 391–2;
Table for, 382–3, 391;

Y

Young, J. W., cited, 178.
Younger generation, 12–3, 14, 15.
Young Men's Christian Assn., 44;
— Women's C. A., 44.

Z

Zimmern, Alfred, book mentioned, 48.
Zoögeography, 269.
Zoölogy, 276.
Zoölogic conformities, 184.

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